ARMY ORDNANCE

VOL. XXIX, No. 153 NOVEMBER-DECEMBER, 1945

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C. E. WILSON OF GENERAL ELECTRIC

"No man can foresee the nature of future weapons"

A REVIEW OF INDUSTRIAL PREPAREDNESS FOR NATIONAL DEFENSE
PUBLISHED BY THE ARMY ORDNANCE ASSOCIATION, WASHINGTON, D. C.

OFFICIAL U. S. NAVY PHOTO

Any port in a storm ... but there are no ports

More than one sailor has said, "It's a helluva place to fight a war!"

That's a miracle of understatement when you know the Pacific as well as the U. S. Navy knows it.

They know how many thousands of miles you have to go before you reach the fighting fronts.

They know there's almost continual rain and bad weather to hamper operations after you get there.

And they know there are no good ports!

Think of the thousands of ships, and the millions of tons of supplies it takes to keep our fighting forces moving toward Japan.

Imagine, if you can, the problem of handling those ships and supplies with no port facilities.

There are no giant cargo cranes... no miles of docks and warehouses...nothing but beaches, and human backs, and a refusal to call any job impossible.

Remember, too:

It takes 3 ships to do the supply job in the Pacific that 1 ship can do in the Atlantic.

It takes 6 to 11 tons of supplies to put a man on the Pacific battleline, and another ton per month to keep him supplied.

It takes a supply vessel, under ideal conditions, half a year to make one round trip.

Add up those facts, multiply by the number of sailors, soldiers, and marines for whom the Navy is responsible.

Maybe you'll begin to realize what "no ports" can mean in the rough, tough waters of the Pacific.

Maybe you'll see that we have *two* reasons to be proud of the U. S. Navy. *First*, the way they've sunk the enemy's ships.

Second, the way they sail *your* ships ... taking the worst the Pacific can hand them... but keeping the supply lines open ...keeping the attack *on schedule!*

SPERRY GYROSCOPE COMPANY, INC. GREAT NECK, N. Y.

★

Division of the Sperry Corporation

LOS ANGELES • SAN FRANCISCO • SEATTLE • NEW ORLEANS
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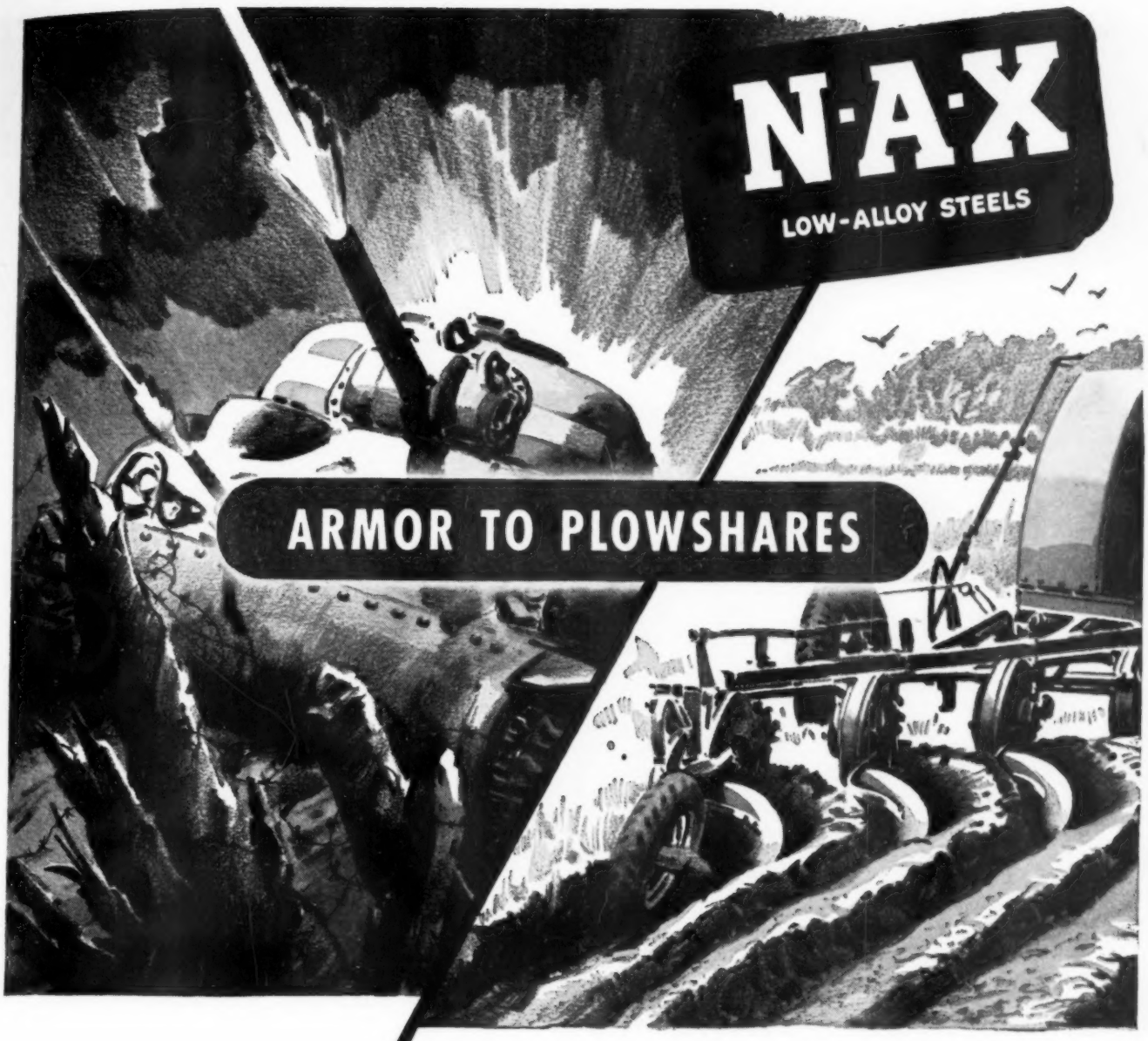
MAKERS OF PRECISION INSTRUMENTS FOR THE ARMED FORCES



It has already happened. . . . One of the fine-grained N-A-X low-alloy steels — steels that have provided armor for tanks and landing craft, frames for all jeeps, and vital parts for scores of fighting vehicles — has been "beaten into plowshares" to produce priority equipment for agriculture.

The particular steel was N-A-X 9120, a carburizing grade. Its ready response to carburization and heat-treatment is utilized to produce a farm implement that is "tough to the core" and that has the required surface hardness to resist abrasion and wear.

The conversion of an N-A-X low-alloy steel from tools of war to tools of peace is not surprising . . . just prophetic. For the same wide range of desirable properties that made these fine-grained steels a great military material recommends their use in civilian products.

GREAT STEELS FROM GREAT LAKES

GREAT LAKES STEEL
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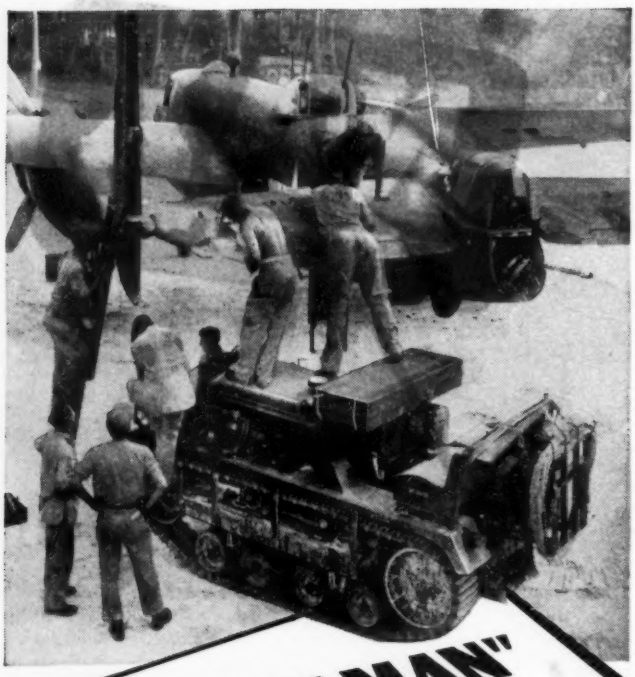
N-A-X ALLOY DIVISION • DETROIT 18, MICHIGAN
UNIT OF NATIONAL STEEL CORPORATION



"HANDY MAN" of the Ground Crew

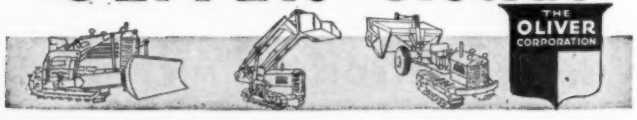
It's a big help in getting planes serviced fast, this special high-speed military model Oliver "Cletrac" crawler tractor. Nicknamed the "bomber's nurse," its versatility and all-around usefulness make it a valued "handy man" to ground crews.

In addition to its primary job of hauling planes, the Oliver "Cletrac" military tractor is a highly maneuverable service station on wheels. It has an energizer for starting the plane motors; an air compressor to inflate tires and service shock absorber struts; a power generator for the operation of flood lights, grinders, drills, and other small electrically operated tools; and a front-mounted winch to handle or hoist heavy materials.

The speed of this Oliver "Cletrac," plus the maneuverability and ease of handling provided by its controlled differential steering, enables it to get the planes off the runways and into the dispersal area *fast.*

The ability of Oliver "Cletrac" tractors to operate efficiently under all types of service conditions . . . in muddy, sandy, or icy ground . . . has made them a valuable addition to our armed forces and makes them equally valuable at home for road building, excavating, mining, logging or hauling tasks. **The OLIVER Corporation,** Industrial Division, 19300 Euclid Avenue, Cleveland, Ohio.

OLIVER - Cletrac



New Developments

ROCKET RESEARCH

Among the many research and development projects designed to produce newer and more efficient means of waging war, the Army Ordnance Department is continuing its long-range guided-rocket program inaugurated early in 1944.

At White Sands Proving Grounds, near Alamagordo, N. M., Ordnance rocket experts and technicians are preparing to conduct extensive tests and studies of the German V-2 rocket. Although interesting and essential data concerning long-range guided rockets may be obtained from these tests, the United States Army does not intend to improve the German missile for adoption as an American weapon. The main purpose of the studies is to uncover any applicable data that may be incorporated in American rocket design.

American occupation of the area around Nordhausen, Germany, resulted in the discovery, earlier this year, of an underground factory for V-2 rockets. A great number of unassembled rockets were found and parts for about one hundred missiles were shipped to the United States.

B-32—NEWEST ARMY BOMBER

The B-32, newest of the Army Air Forces' big bombers, features heavy firepower and bomb load, long range, and a speed of more than 300 miles an hour. It is an all-metal, high-wing, single-tail monoplane with a cylindrical, semimonocoque fuselage and a modified Davis low-drag wing with Fowler-type flaps. The tricycle landing gear, which uses dual tires, is fully retractable and has a completely swiveling nose wheel.

Power is supplied by 4 double-row, 18-cylinder Wright Cyclone engines of 2,200 horsepower each. Wing span of the B-32 is 135 feet; length is 83 feet 1 inch; and height is 32 feet 2 inches. It has a wing area of 1,422 square feet and a gross weight of approximately 100,000 pounds.

TEAR GAS GRENADE

The Army has adopted a new tear-gas grenade for use by MP's or occupation troops. Shaped like a baseball, the grenade is fired by pulling a safety pin and holding a finger over a release plug, then throwing the missile as a ball is thrown. The plug is forced out, and the thin plastic coating bursts, scattering a fine powder spray which acts immediately.

GLASS ARMOR

Glass armor was extensively used in actual combat by the Navy during the recent war and was also worn to some extent in combat ashore by the Marines.

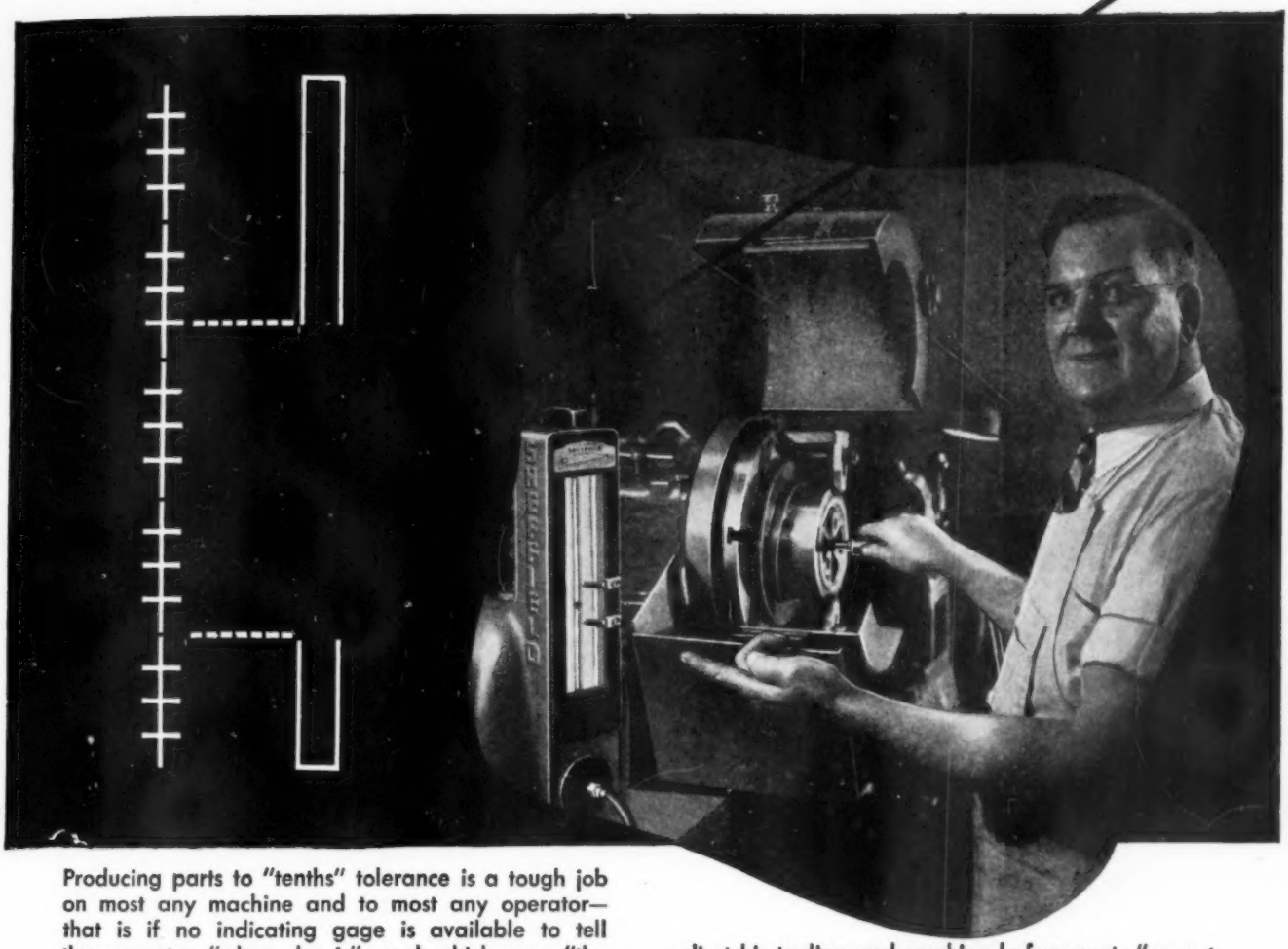
The glass is in the form of exceedingly tough fibers woven into fabric and impregnated with a hard plastic. It makes plates that are claimed to give better protection, weight for weight, than steel. It has the considerable advantage over steel of not throwing off injurious splinters if struck by fragments of exploding projectiles. The armor was invented by Brig. Gen. G. F. Dorion, Q.M.C.

RECOILLESS CHEMICAL MORTAR

When the war closed, the Chemical Warfare Service had a recoilless mortar "goon gun" in the field and ready for battle use. It is a new brother of the famous and battle-tested 4.2-inch chemical mortar. The recoilless 4.2-inch weapon weighs only 170 pounds, about half the weight of its older brother. Using a

Checking to "TENTHS"

can be like reading inches on a yardstick



Producing parts to "tenths" tolerance is a tough job on most any machine and to most any operator—that is if no indicating gage is available to tell the operator "where he is", and which way "the machine is going."

With a Precisionaire to use right at the machine on which the operator can read "tenths" as he would read inches on a yardstick, he can see "where he is". Working to "tenths" becomes as easy as working to "thousandths". And most important of all, he knows that every piece accepted on the Precisionaire is "right".

Scrap is reduced to a few incorrect pieces possibly made during the machine setup—no additional scrap need result as the Precisionaire tells the operator to adjust his tooling and machine before parts "go out of tolerance".

The Precisionaire checks internal or external dimensions with equal accuracy. It is available in four models of different amplifications for tolerances ranging downward from .005" to fractions of a "tenth". Hundreds of Model No. 600-0 are being used in various plants right at the machine to check to plus or minus five millionths of an inch. Thousands of lower amplification models are used daily in receiving, process and final inspection in the nation's production plants.

THE Sheffield CORPORATION

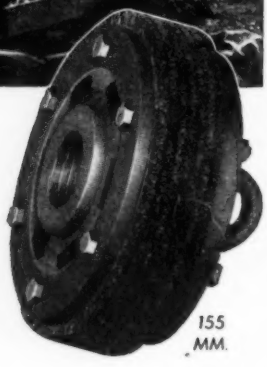
SHEFFIELD MASTER CRAFTSMEN

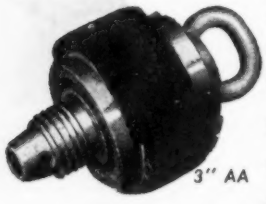
Dayton 1, Ohio, U.S.A.

MACHINE TOOLS • GAGES • MEASURING INSTRUMENTS • CONTRACT SERVICES

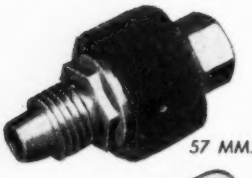
Fullergript Bore Cleaning Brushes

Made to Ordnance Specifications from 37 mm. up to and including 240 mm:

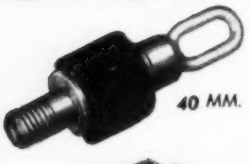


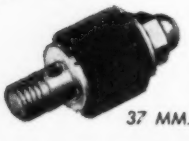


Above is shown the popular 155 mm. brush such as is used for the famous Long Tom Gun. Other size brushes are used for anti-aircraft batteries, tanks, and pack howitzers. Brushes are also provided for cleaning breech mechanisms and elevating gears.



Fullergript Brushes are made to Naval Gun Factory specifications from the one-pounder size up to the six inch gun.





We act as prime contractor or can sub-contract brushes or parts to manufacturers of carriages and accessories.

THE FULLER BRUSH COMPANY
Industrial Division Dept. 8C
3585A MAIN STREET • HARTFORD 2, CONN.

standard caliber .30 machine-gun mount, it does away with the heavy base plate of the "goon gun" and the necessity for preparing a position in advance. Three men can handle it conveniently.

The new weapon owes its nonrecoil to a tube and reaction chamber, the latter being screwed on the rear of the barrel. Open at the far end, this chamber allows gas from the explosion of the propelling charge to escape to the rear to compensate for the jar from ejection of the shell. Vanes in the chamber provide angular momentum to counterbalance rotation of the shell in the mortar's rifling.

The new mortar can be elevated 45 degrees, depressed 15 degrees, and traversed 360 degrees. It can be fired off its tripod —from vehicular gun mounts or from its own combination carrying-and-ammunition cart. For high-angle fire, the shell is dropped into the muzzle in conventional mortar fashion, and gravity does the rest. At near horizontal or depressed elevations, it is fired by a driver rocket. The latter is a contrivance which fits on the head of the shell. Pulling a pin from the driver rocket as it projects from the muzzle of the weapon propels the shell backward into the tube where it strikes the firing pin and is then sent forward on its destructive flight.

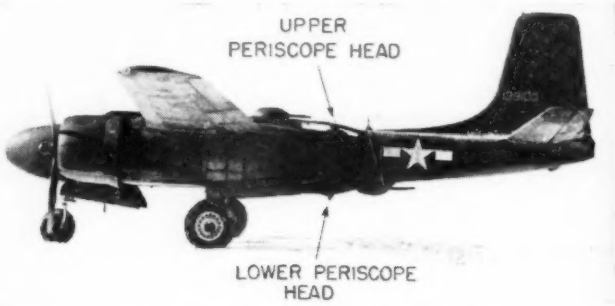
PERISCOPE GUN SIGHT

Details of the revolutionary gunnery system of the Army Air Forces' attack bomber, the A-26 Invader, have recently been disclosed by General Electric Company, designer and builder of this equipment.

Major part of the A-26 gunnery system is the periscope gun sight, which passes completely through the fuselage of the plane, with sight heads emerging from both the top and the bottom as shown in the accompanying illustrations. Remote control links the novel sight with two 2-gun turrets, so that each time the gunner moves his sight to follow an attacking plane the gun turrets move similarly, as if the two were one piece of equipment.

Both the upper and lower A-26 turrets and the periscope sight are controlled by a single gunner who is located in comparative safety in a remote sighting station.

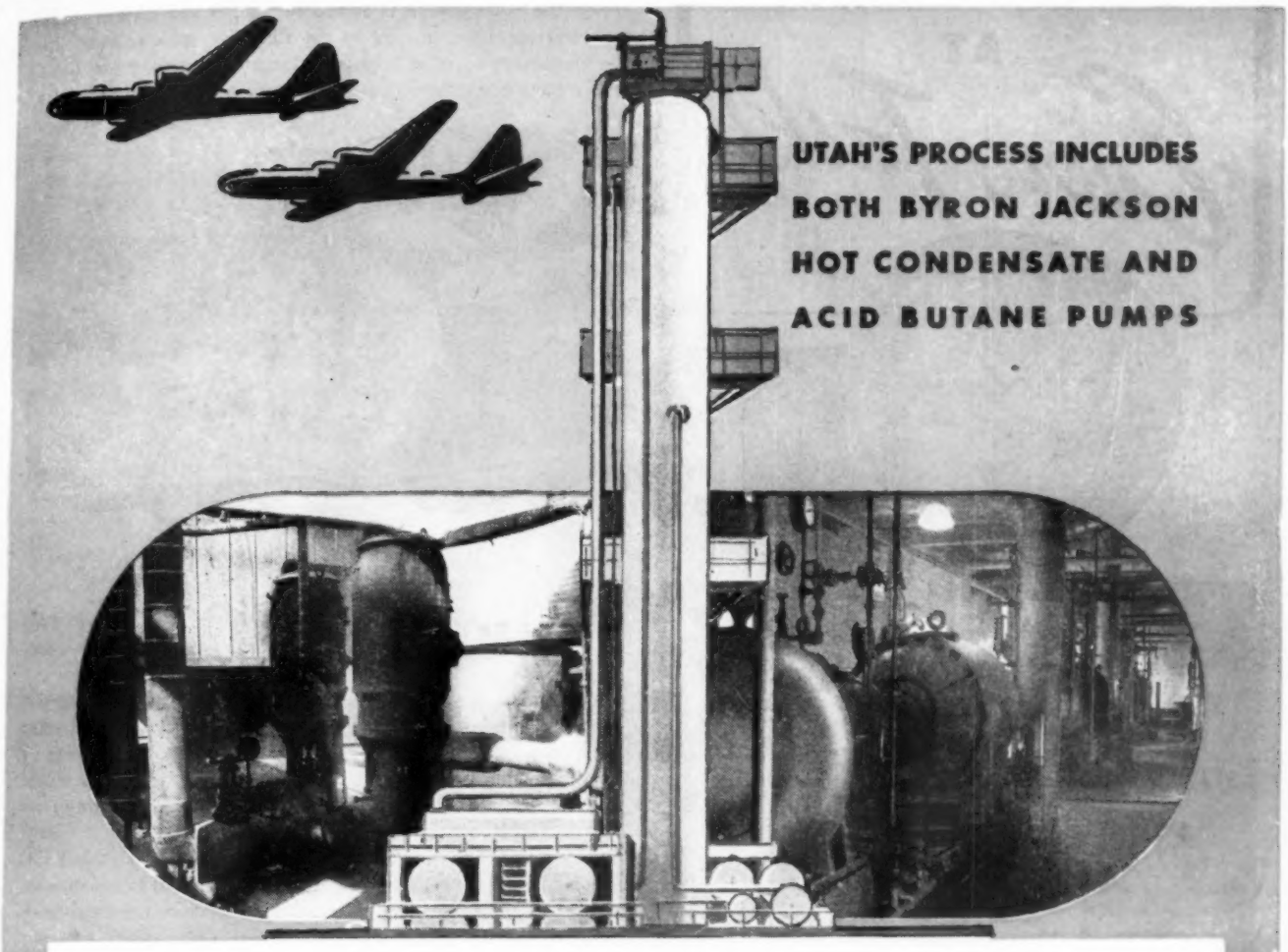
The 2-headed arrangement of the periscope sight allows a gunner to scan the skies for an enemy in the area above his own plane, to either side of it, or beneath it. When an attacker climbs or dives from one hemisphere to another, a flip-over mirror within the instrument transfers the gunner's line of sight from one end of the periscope to the other and does so with such rapidity that he never loses track of the target.



A-26 Invader with periscope gun sight.

Gun turrets follow movements of the periscope sight so rapidly that the two move almost simultaneously. This precision of motion between the sight and the guns is made possible by ingenious electrical devices called selsyns, which transmit an electrical message to other selsyns in the turret about which way the guns must move. After being amplified, this electrical message is converted into power that runs motors and directs the turrets, bring-

IN NAPTHA ISOMERIZATION



UTAH'S PROCESS INCLUDES BOTH BYRON JACKSON HOT CONDENSATE AND ACID BUTANE PUMPS

These vertically mounted multi-stage hot condensate pumps, arranged in a barrel, eliminate the necessity for elaborate and objectionable pits in order to provide pumps with required npsh, minimize space requirements and permit installation at the most suitable location with the least piping. There is only one stuffingbox—under discharge pressure—thereby excluding air leaks, while vertical shaft—free from vibration and deflection—assures long life for packing.

The acid butane pumps are double volute horizontal units with water-jacketed bearing bracket and a single water-jacketed stuffingbox subject to suction pressure only. Fresh butane is fed direct to stuffingbox to assist in preventing acid contacting packing and a drip basin under the box protects the bearing bracket. An "in and out" seal connection is provided to the stuffingbox lantern ring—and there are no small threaded pipe-taps or lock pins in contact with acid mixture. Stuffingbox is easily accessible for inspecting or repacking, and entire pump may be dismantled without disturbing either suction or discharge pipe or the driver.

Pumps for any given process or application will be designed to fit your particular requirements.

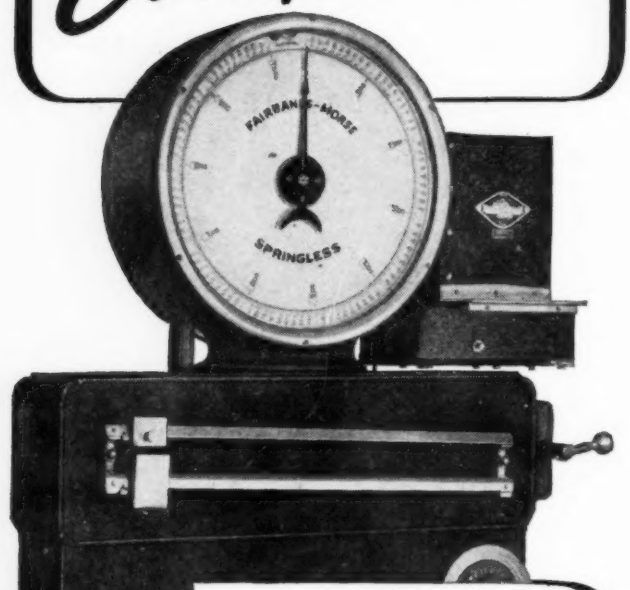
CENTRIFUGAL AND TURBINE PUMPS

BYRON JACKSON CO.

Houston • LOS ANGELES • New York

SUBMERSIBLE MOTORS

BUILT TO LAST AT *Every Task!*



Fairbanks-Morse Scales are known throughout industry for long life. And there's a reason. Years of engineering experience have taught us how to design scales that can lick the toughest weighing problems or most adverse conditions met in industry. And, in many cases, they can speed up production at the same time. Let a Fairbanks-Morse engineer show you how these scales can help solve your problems. Here are just a few of the things they can do:

- Weigh and disburse preset amounts automatically.
- Keep ingredient proportions secret.
- Weigh materials or products in motion.
- Count small parts and products.
- Read themselves at the touch of a button, and print weight records and receipts.

For further information, write Fairbanks, Morse & Co., Fairbanks-Morse Building, Chicago 5, Illinois.

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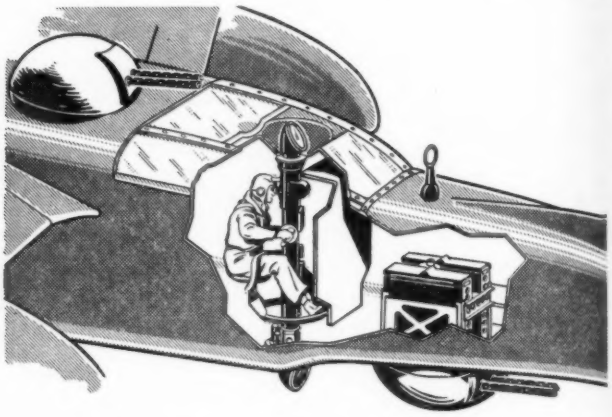
Fairbanks-Morse

A name worth remembering

Diesel Locomotives • Diesel Engines • Generators • Motors • Pumps • Scales
Magnetos • Stokers • Railroad Motor Cars and Standpipes • Farm Equipment

ing the guns quickly into alignment with the sight. In battle action the A-26 gunner is seated so that he can revolve around the periscope tube, his eye to the sighting eyepiece, and follow the maneuvers of an attacking ship in any quarter of the sky.

Protection is afforded the gunner by a shield of armor plate



Position of gunner using the periscope sight.

which, as the gunner moves around the periscope tube to keep his sight trained on a rapidly maneuvering enemy, moves accordingly and covers him from enemy fire.

The optical system for the periscope sight, similar to optical systems used in submarine periscopes, was originally designed by Bausch & Lomb Optical Company and was later modified by the Eastman Kodak Corporation. Both of these organizations, together with Farrand Optical Company, built periscopes for the system.

Top speed of the A-26, which is powered by 2 Pratt & Whitney 2,000-horsepower engines, is in excess of 350 miles an hour, and cruising speed is 300 miles an hour. Besides the single gunner, the combat crew includes the pilot and an auxiliary crewman.

RIFLE WRAPPING

Ordnance has developed a time-saving machine for wrapping rifles dipped in rust-preventive compound. With this power-driven rifle-wrapping machine, the rifle revolves while the operator feeds the greaseproof paper. Shops are able to handle more than 400 rifles a day with a staff of 4 men. In hand wrapping, this operation would require 8 men to wrap 300 rifles.

THE NEW P-51H MUSTANG

A new and improved version of the famous P-51 Mustang fighter that will fly faster, higher, and farther than previous models is the P-51H, similar in appearance to the P-51D, but it incorporates more than fifty aërodynamic and structural changes. Among the more obvious improvements are a new lower drag airfoil section, redesigned fuselage contours for better pilot visibility, cleaner fairing of the radiator ducts into the fuselage, increased size of the horizontal and vertical tail surfaces, and installation of the latest model of the Packard-built Merlin engine of more than 2,000 horsepower. Speed of the P-51H is announced as better than 460 miles an hour, its service ceiling approximately 42,000 feet, and operating radius more than 1,000 miles.

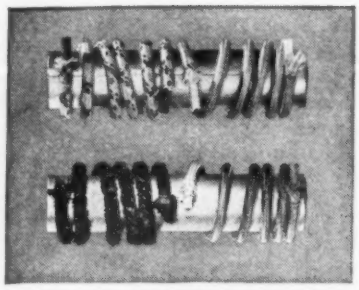
GERMAN 380-MM. MORTAR

The Germans developed during the war a 380-mm. mortar or howitzer which was mounted on a fortified Mark VI Royal Tiger tank chassis. The front armor of the vehicle is five inches deep and is mounted at an angle of fifty degrees. At the rear it is four inches thick. The mortar barrel is seven feet long and is

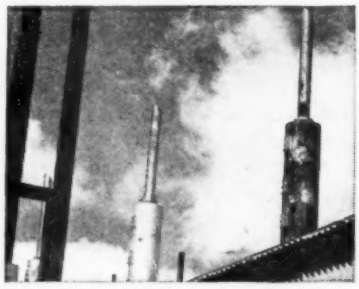
DOW CORNING

SILICONES

revise old concepts of the properties of materials



Cable insulated with Dow Corning Silicone rubber (at right) shows no change after one hour at 250° C., in contrast with organic rubber, which has melted and exuded freely through the braid.



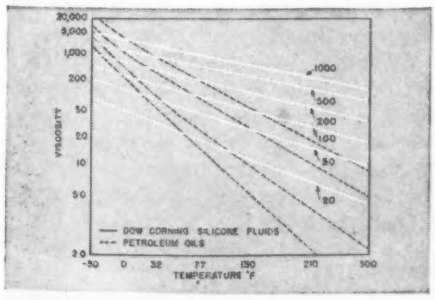
The excellent condition of the stack at left, protected with silicone based paint, indicates the ability of such finishes to withstand moisture, oxidation, ultra-violet rays and temperatures up to 800°F.

American industry has been quick to prove the outstanding advantages of Dow Corning Silicone products. The greater heat stability, inertness to water and chemicals, and the excellent dielectric properties of these high polymeric substances radically change old concepts of the properties of materials.

Among DC Silicone products commercially available are: Fluids notable for low rate of viscosity change over a wide temperature range; Lubricating Greases for service at temperatures down to —70°F. and up to 400°F.; special Stopcock and Plug Cock Greases; Varnishes and Resins for impregnating, coating and bonding, and for waterproofing asbestos, mica and Fiberglas cloth; Silastic*, a rubber-like silicone material for molding, coating, extruding and laminating.

Inquiries are invited.

*TRADE MARK, DOW CORNING CORPORATION



Here is graphic illustration of the fact that Dow Corning Silicone fluids undergo strikingly little change in fluidity over a wide range of temperatures.

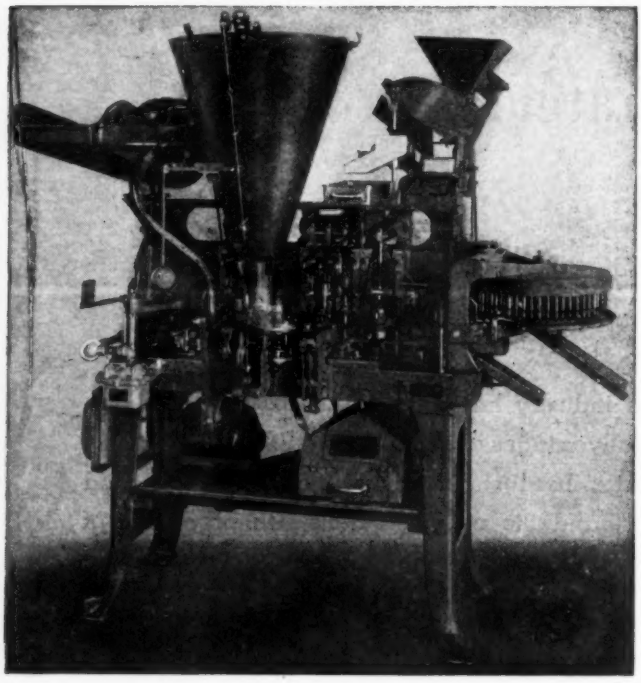
DOW CORNING CORPORATION
MIDLAND, MICHIGAN

New York Office: Empire State Building

Dow Corning

FIRST IN SILICONES

SMALL ARMS
AMMUNITION
MACHINERY



CARTRIDGE LOADING MACHINE
For Caliber .30 Cartridges

One of our large family of Small Arms Ammunition Machinery. This line is the outgrowth of long experience in the development of machinery for the mass production of bullets, cartridge cases, etc., and the handling of explosives.

While the equipment is used extensively in U. S. Government Arsenals, the line includes also various machinery adapted to the manufacturing practices of England, Canada and other foreign countries.

WATERBURY FARREL
FOUNDRY AND MACHINE COMPANY
Waterbury Connecticut, U. S. A.
SALES OFFICES:
CHICAGO CLEVELAND NEWARK, N. J.

rifled. The base of the shell is 15 inches in diameter, and it is 5 feet long, weighing 770 pounds. It is loaded into the tank by means of a crane and then into the breech of the mortar by a hoist inside the tank. There is no recoil—the shell is projected by a propelling charge inside the shell itself.

DECK-EDGE CARRIER ELEVATORS

The Navy hurled its carrier-based bombers and fighters against the Japs by means of a unique "deck-edge" elevator that whisks planes up the outside of the ship to the flight deck in a matter of seconds. Now being installed on the Navy's new fleet of MIDWAY-class supercarriers, the unorthodox new elevators have secretly been in battle service for 2½ years on the 27,000-ton ESSEX-class fleet in every major task-force operation in the Pacific.

VHF SPEEDS INSTRUMENT LANDINGS

Safe aircraft instrument landings at overcast airports at 3-minute intervals are now possible by a new technique and very high frequency radio apparatus developed by the U. S. Civil Aëronautics Administration at its experimental station at the municipal airport in Indianapolis. By this method approximately twenty planes can be brought safely in on a single runway in an hour, while under the usual method the number is only four or five. It doubles the number of instrument landings an hour over that obtained in a method demonstrated only several months ago at the Washington, D. C., airport by the same organization.

When visibility is such that landings must be by instrument, approaching planes, under radio orders from the control tower at the port, must be "stacked up," circling at levels 1,000 feet above each other at some distance from the field, waiting often an hour or more before they can be permitted to land.

Very high frequency radio, called VHF for short, is the key to the new technique. Its great advantage is that the VHF channel is basically static-free; with the present lower frequency radio, static causes much difficulty.

The new technique does not employ radar, but a combination of the VHF control and radar will probably be used later. The technique of stacking and communication with the "stacked" planes is important in the new method. Planes are held behind a radio vertical "fan marker" ten miles from the tower on the approach airlane. With the VHF radio equipment all pilots in the "stack" can hear the instructions to any individual plane, and therefore be ready when their specific instructions come.

JET-PROPELLED COMBAT

Combat nine miles above the earth's surface by jet-propelled planes whose terrific speeds will hurtle them toward each other at more than 1,000 miles an hour will require gun turrets and gun sights to be mounted flush or within the skin line of the jet plane, and even gun barrels will not be allowed to protrude.

The jet-propelled bomber of the future will probably include: (1) Multiple-gun, remotely controlled nose and tail turrets; (2) Periscope sighting stations, either double-ended and mounted vertically in the airplane, or single-ended, mounted horizontally and capable of sighting in a forward or aft hemisphere; (3) Computers with hair-trigger brains that will make the most of limited effective firing range by overcoming problems of accurate lead computation and the like.

GERMAN V-3 ROCKETS

Batteries of long-range guns, capable of hurling rocket shells 100 miles to rain down on London at the rate of 600 an hour—that was Germany's third secret weapon.

The launching site of the V-3 was discovered at Mimoyecques, near Calais. The British Information Service said the battery

RECONVERSION TO CIVILIAN PRODUCTS

makes LOW-COST an important production factor... use dependable

OAKITE CLEANING

36 Years' Experience

Long experience serving thousands of plants manufacturing practically every civilian type product, implemented by successful experience in finding the right answers to complex production-cleaning problems on a wide range of war supplies, provides the sound basis and reasons that prompt so many leading concerns to select and rely on the Oakite organization for authoritative technical help and the materials and methods that keep production volume up and costs down.

You are invited to apply this valuable experience to your work, particularly when changing over from war to civilian supplies.

70 Different Cleaning Materials

Available to meet the high standards of today's stream-lined production, whether for degreasing, machining, grinding, stamping, drawing, burnishing, descaling, rust removal or other related operations, are over 70 different Oakite materials specifically designed to assure speed, thoroughness and production economy on the work to which they are applied. Uniformity and high quality of Oakite materials is maintained and assured through constant factory batch-inspection by Oakite chemical engineers. Each Oakite material is guaranteed to perform as specified or it costs you nothing.

Nationwide Service

Oakite's field staff of technically trained men with their intimate knowledge of metal surface preparation requirements and the operations associated with them are always at your service, as also our chemical and mechanical research laboratories, without cost or obligation. This personal help and advisory service is yours for the asking on any reconversion production-cleaning problem.

Stocks of various Oakite materials are warehoused at strategically located transportation points that make possible delivery of materials when they are needed.

TELL US YOUR PROBLEM: The operations of cleaning and surface preparation figure so largely in production cost that Oakite offers all its comprehensive facilities and "know-how" to keep them on an economical basis. Whatever your product or cleaning problem, write us today. All inquiries promptly answered.

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Technical Service Representatives Located in All Principal Cities of the United States and Canada

CHEMICALS
ACP
PROCESSES

Salvaging and Reconditioning

ACP Products Solved Many Cleaning and Conditioning Problems in War Production. Many of these products will be useful in salvaging or reconditioning used or stored war matériel.

The American Chemical Paint Company has developed in its laboratories many chemical products for cleaning, conditioning and protecting metal surfaces; a partial list and their purpose follows:

Rust Removal—*Deoxidine 170*
Rust Prevention—*Peroline*
Acid Waste Prevention—*Rodine*
Copper Coating—*Cuprodine*
(Without Current)
Preparation for Paint—*210 A Deoxodine*
(Cleaning and Conditioning)
Final Rinse—*Deoxylyte*
(Promotes Enduring Finish)
Heat Resisting Paint—*Kemick*
Metal Stripping Solution—*Actalyte*

The American Chemical Paint Company has served Industry through two World Wars and the intervening years of peace. This experience in the removal and prevention of rust and other applications of chemical products to the metal-working industry is available. Our Technical Department will gladly assist in the most effective application of our products to your manufacturing requirements.

Manufacturers of Inhibitors & Metal Working Chemicals

AMERICAN CHEMICAL PAINT CO.
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Note: West Coast Plants may address inquiries and orders for prompt delivery to: Leon Finch, Ltd., 728 East 59th St., Los Angeles, Calif.

consisted of 50 smoothbore barrels, each 400 feet long, sunk 350 feet into the hills at an angle of 55 degrees. The guns had been arranged in 2 batteries of 25 each, trained on London, 95 miles away.

The whole installation, covering several acres, was protected by 18-foot concrete armor that, if it had been completed, would have been invulnerable to any then-known bomb.

STRATOSPHERE TELEVISION BROADCASTS

Plans to inaugurate a new system of television and frequency-modulation radio broadcasting from stratosphere airplanes cruising six miles in the air, as soon as permits and equipment can be obtained, have been announced by the Westinghouse Electric Corporation. If successful, "Stratovision" would make coast-to-coast television and frequency-modulation broadcasting possible at a reasonable cost and would permit these services to be broadcast to even the most isolated farm homes many years ahead of any previously suggested system. It would reduce the astronomical expenditures which have hampered all earlier concepts of nationwide television service. Television and frequency-modulation radio waves travel in a straight line and for all practical purposes stop at the horizon. This means that television broadcasts from the highest practical tower erected on the ground cannot be received much more than fifty miles away, and thousands of such towers would be needed to cover the entire country. Broadcasting from the stratosphere will eliminate the need for such towers.

RADAR FOR BLIND LANDINGS

Landing of airplanes by radar at night and in bad weather is no longer a dream of the future. Radar-aided landings have been an accomplished fact for the past twenty-one months, it was learned recently when the Navy permitted revelation of the development and use of a new Ground Control Approach radar system. Known to Navy pilots as "GCA," this radar system has enabled Navy planes to operate from both domestic and foreign bases in practically all weather short of a full gale.

The new system enables a highly trained ground operator to watch on a screen every movement of an incoming plane within a radius of approximately twenty-five miles from the landing field. From the radar screen the "ground pilot" can tell from which direction the plane is approaching, its position with respect to runways, and its altitude. This information the ground pilot relays by voice radio to the plane's pilot together with exact control instructions until the plane's wheels touch the runway.

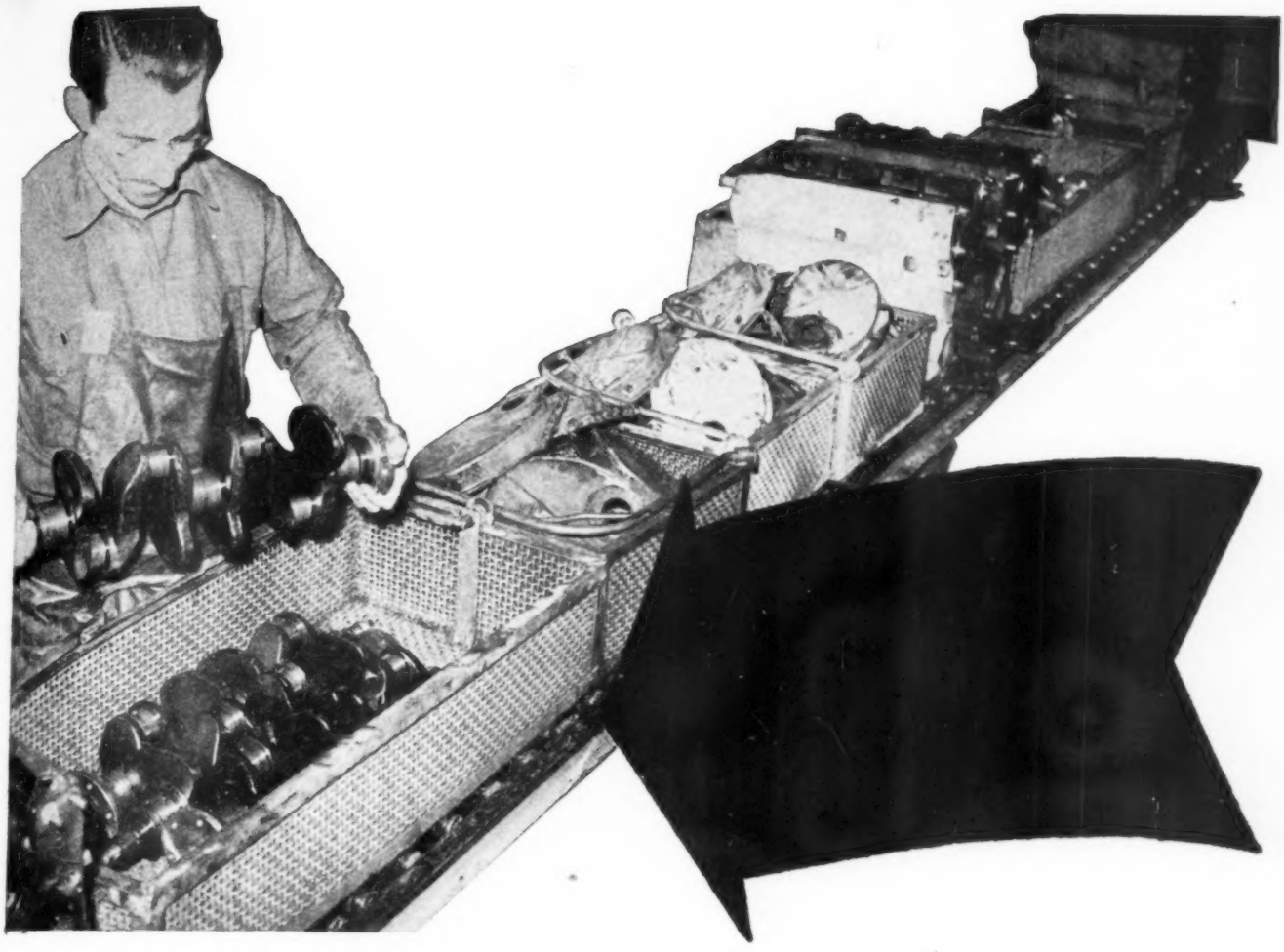
NAVY CONCRETE SHIPS

Probably the least known unit of the Navy is the "crockery fleet"—a flotilla made up entirely of concrete ships. Built as a steel-conservation measure, these vessels serve as floating supply depots. As such, they are part of the huge mobile bases that the Navy operates in the western Pacific.

The concrete ships, or "Green Dragons" as they are known to Navy men, act as warehouses afloat. Fast-traveling cargo and provision ships that make the run out to the far reaches of the Pacific transfer their cargoes to the "crockery" ships which then retransfer the supplies to combatant vessels as needed. Through this system, the high-speed cargo and food ships are able to turn around and return to the United States for another load without awaiting piecemeal discharge of their cargoes.

FAST GERMAN SUBMARINES

Six new-type German submarines, captured in Oslo fjord by the British, had the unusual speed of eighteen knots submerged. Diesel engines, rather than battery-driven electric motors, propel the submerged ships, with the engines getting air by means of a



Turco, Pioneer of Methods and Materials for Mass Cleaning

Through Surface Chemistry*... Turco chemists and engineers have helped develop and install many of the finest and most efficient *Mass Overhaul* production lines in the country. Some have been for the Army, some for airlines, some for large industries and fleet operators, others for smaller overhaul companies.

Through this experience, Turco experts are not only able to give valuable (and not otherwise available) counsel on *new* installations, but are also excellent trouble-shooters on installations which have gone wrong.

Surface Chemistry Develops Amazing Cleaning Materials

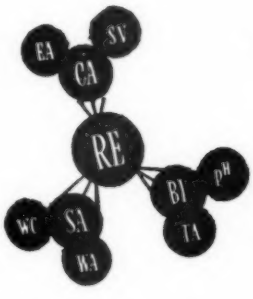
Vital to the success of mass production are cleaning materials which produce *consistently* clean parts on split-second time schedules. Because Turco scientists have pioneered in modern *Surface Chemistry*, you can now benefit from numerous special cleaning compounds in mass overhaul—compounds which are not only economical and simple to use, but which also deliver brilliant performance under exacting production line conditions.

Turco Automotive Division Provides Counsel and Assistance, Free

Turco automotive experts will not only tell you about Turco materials, but also about the latest production line methods. If you are contemplating an installation, or if you have a production line which is below efficiency, feel free to write to Turco. We will have one of these experts call. There is neither cost nor obligation.

Send for Free Book

No. A-728 "How to Plan & Install Production Line Methods for Mass Automotive Engine Rebuilding." Original and last-minute material and illustration, written by Turco Chemists and Maintenance Experts. Your letterhead, please. Dept. BT-7.



*What Surface Chemistry is:
WA—Wetting Action
EA—Emulsifying Action
SV—Saponifying Value
SA—Solvent Action
CA—Colloidal Activity
WC—Water Conditioning
BI—Buffer Index
PH—Energy of Alkalinity
TA—Total Alkalinity
RE—Research and Experience

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MANUFACTURERS OF ALL-WHEEL-DRIVE VEHICLES
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Purveyors to U.S. Army, U.S. Navy, U.S. Marine Corps and Many Foreign Governments

tube which goes above the surface of the water like a periscope. Streamlining is emphasized by enclosing the bridge and by mounting the fore and aft deck guns in the same conning tower.

FOG DISPERSAL SYSTEM

When heavy fog banks close in on airfields, it is difficult for returning planes to land safely. But now with a series of special burners to convert aviation fuel into vapor gas and thus evaporate excess moisture in the air, low-lying clouds are effectively broken up and normal flight operations may continue even with zero-zero weather.

The system was first introduced by the British in early 1943, although a similar arrangement has been perfected by Air Technical Service Command equipment laboratory engineers. In the AAF system, several large tanks store the fuel to be used, a pumping system pressures the gasoline through the pipelines that border the runway, and a series of burners consume the gas with a clear flame while automatic valves regulate and control the heat. A preheating system vaporizes the gasoline and ejects it through small jets. During one test at Wright Field, the system lifted a heavy ground fog in ten minutes.

MAMMOTH AIRPLANE TIRE

A huge Goodyear airplane tire has been constructed out of 36-ply nylon and rubber, measuring 110 inches in outside diameter and 44 inches in cross section. It weighs 1,500 pounds, and one-third of its weight is nylon. Under hydrostatic test the tire has been able to withstand water pressures up to 375 pounds per square inch. Only one of these tires would be required to support the weight of a fully loaded B-29.

NEW LIFE PRESERVERS

New yoke-type life preservers designed for wear with full infantry equipment have been developed by the Navy for the use of troops carried aboard transports. The new preservers, made of kapok, will replace the present carbon dioxide dual-tube life belts which are worn with difficulty by troops laden with full packs and equipment. The design, perfected as a result of extensive tests, is such that a soldier's pack can be removed without taking off the preserver.

QUININE PRODUCTION SPEEDED

The Corps of Engineers has developed and made ready for practical use a field method of extraction of quinine from cinchona bark, a procedure that may revolutionize quinine manufacture in so far as rapid production and saving of shipping time and space are concerned.

The development is a portable 1,500-pound extraction unit that can produce—at the scene of harvest—170 pounds of concentrate (totaquine, from which quinine is derived) per month from 13,000 pounds of green bark with the use of only 1,000 pounds of chemicals.

CARGO PARACHUTE SUBSTITUTE

An efficient substitute for cargo parachutes has been perfected in the form of a fiberboard and plywood box with collapsible rotors or wings which open when the container is dropped from a plane, limiting its rate of fall to a slow spin.

The 12- by 12- by 34-inch cargo carrier will support fifty pounds of supplies, and its speed of descent so nearly approximates that of a parachute that fragile items, such as glass, may be loaded into it without danger of breakage.

NEW COMBAT CAMERAS

Two new cameras, one for motion pictures, the other for stills, have been developed for combat photographers by the Signal Corps as a result of suggestions received from the cameramen.

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T/5 JOHN DOE, CAMP SMITH, ARIZ.
SUGGEST YOU GET IN TOUCH WITH RICHARD R ROE, BLANK
MANUFACTURING COMPANY, CHICAGO, WHO HAS OPENING FOR
PRODUCTION ENGINEER OF YOUR QUALIFICATIONS. BEST OF LUCK.
-ARMY ORDNANCE ASSOCIATION

The Ordnancemen's Professional Service is going great guns. Every day telegrams like the above are sent to Ordnancemen and women throughout the land.

The purpose of the Army Ordnance Association's Professional Service is to help industry and Ordnancemen get reëstablished on a peacetime basis as quickly and as satisfactorily as possible. Industry is invited to make known its personnel needs to us. Ordnancemen and women are invited to inform us of their availability. We try to put the right person in touch with the right employer. Few questions are asked, no questionnaires are permitted, statistics are few and far between, the entire transaction is in confidence, it is all free.

To all employers: Please send us a statement of your personnel needs. We will publish them in a 50-word advertisement without cost in FIREPOWER, our bimonthly magazine for Ordnancemen. We will refer qualified applicants to you for consideration.

To all Ordnance personnel, men and women: Send us a statement of your qualifications if you are interested in trying to locate a better job than you had before you went into the service. We will refer you to prospective employers who need people of your qualifications. There is no charge, membership in the Army Ordnance Association is not a prerequisite, requests will be acknowledged without undue delay.

It is as important for the welfare of our country that, having helped mobilize our Ordnance man power, we now help demobilize it to keep America strong.

ARMY ORDNANCE ASSOCIATION

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Builders of

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Established 1881

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For the Thrill that Lasts
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9-11 Melcher Street

Boston, Mass.

New Developments

The motion-picture camera, fully loaded, weighs sixteen pounds. It has a gunstock base, permitting the camera to be swung to the shoulder like a rifle. Four lenses of different focal lengths are instantly interchangeable.

The still camera, equipped with two lenses and using 2¼- by 3¼-inch film pack, is all metal, designed to withstand tropical humidity and fungus growths. There are no bellows or leather fittings to rot away.

AIRCRAFT ENGINE COOLING FANS

Through the mounting of cooling fans on certain types of aircraft engines, as much as 200 additional horsepower may be made available at high altitudes or in climbing. The fans, which are driven by the engines they help cool, are installed directly behind the propellers and serve to increase the flow of air among the finned cylinders of the engines at greatly reduced drag.

GERMAN JET HELICOPTERS

The Germans produced four working models of jet-propelled helicopters just before the war ended, and United States air experts are studying two models that fell into Army hands. Charles Lindbergh, the transatlantic pioneer, may come to southern Germany to view them.

One model was a 135-horsepower craft, a double-seater. The others were single-seaters of sixty and ninety horsepower. The latest model developed used about thirty-five gallons of fuel an hour for hovering, and ten gallons for traveling. It was adapted to take off or land with jet propulsion but to travel with ordinary engines and rotors and on a number of types of fuel.

GAGE FOR BLIND OPERATORS

A new electronic sound gaging device, which may mean employment to thousands of America's otherwise unemployable blind, has been developed by the Timken Roller Bearing Company, Canton, Ohio. There is a small, cone-type speaker mounted on the back of the operator's chair and connected with the electronic device on the gage. The operator hears three different notes issuing from the speaker. An article that is normal or within the size limit is indicated by the sound of the middle note. The high note indicates that the article is oversize, while the low note indicates that it is undersize. At the sound of either of these notes, the operator rejects the article under inspection.

A NEW ALTITUDE RECORD

Chief Pilot Joe Towle unofficially broke the American altitude record when he flew a pickaback P-38 Lightning fighter up to 44,940 feet during a flight to test a new-type pressure oxygen mask. Towle, with Col. Randolph Lovelace, chief of the Army's aëromedical laboratory at Wright Field in the pickaback seat, made the flight in great secrecy April 30, 1943, to try out the new mask that forces oxygen into the lungs of the man wearing it and permits him to fly much higher than with conventional equipment. The mask, which worked perfectly during this test, is now used by the Army on all high-altitude ships, including the B-29's. The 44,940 feet was the highest altitude mark ever achieved by a reciprocating-engined airplane in the United States. The world altitude mark of 56,046 feet is held by a specially built Italian Caproni plane which set the record in 1938.

GERMAN EXPLOSIVE SPEEDBOATS

The Germans along the European coast used small, wooden explosive speedboats to combat allied shipping. Around the upper edge of the bow they had a spring-supported framework electrically connected with the detonating charge. When the boat was ready for the attack and the detonating device was set, a bump against the framework sufficed to set off the explosive charge, which weighed several hundred pounds. (*Continued on p. 380*)

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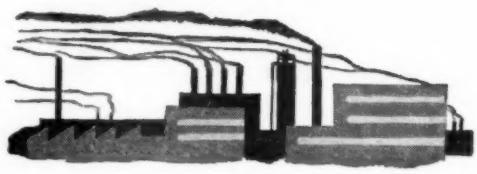
can go to work for YOU

We have fought the war to a finish! All of the famous Gar Wood engineering and production facilities had but one purpose . . . to produce the BEST possible equipment in whatever quantities were needed by our fighting men.

Gar Wood engineers have played a strong part in designing superior machines of war. Now that Victory has been won, yau can depend on that same engineering "know-how" to produce the specialized equipment you want.



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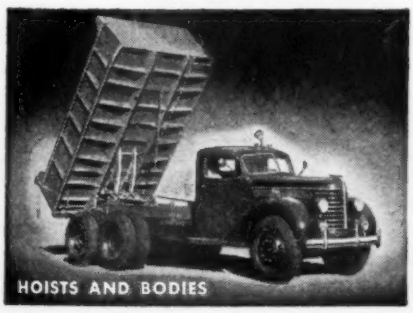
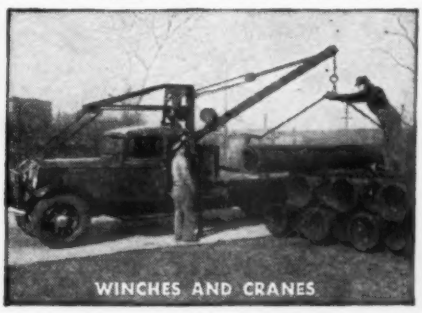
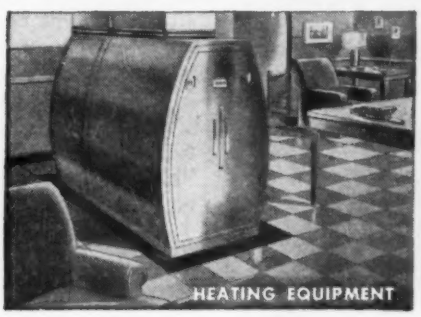

HOISTS AND BODIES


WINCHES AND CRANES

TANKS

ROAD MACHINERY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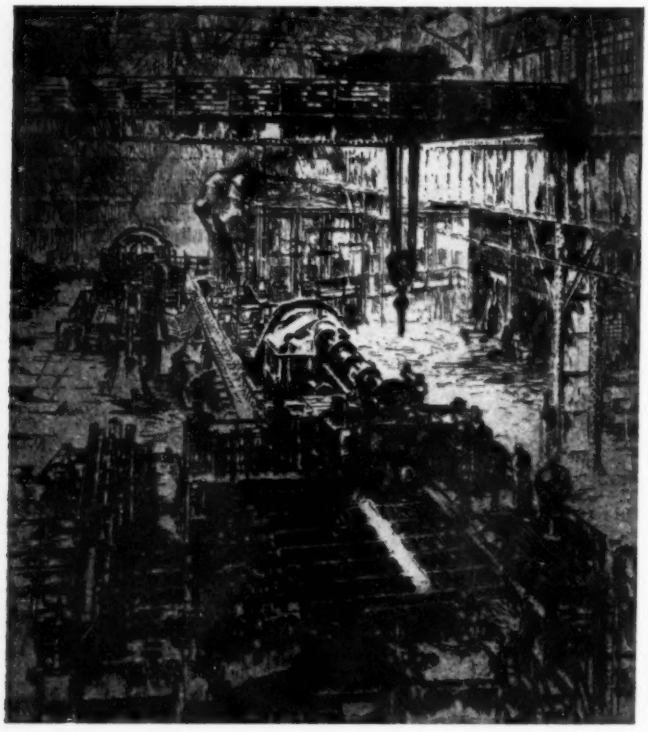

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ARMY E NAVY

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ASSOCIATED COMPANIES

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New Developments

The boats were always operated in packs and were accompanied by a command boat which picked targets and ordered the attack. When the explosive boat was headed for the target, the pilot set the detonating device, locked the steering gear in position, and let the boat drive at top speed toward the target, while he himself leaped backward into the water to be fished out by the command boat.

DYE INDICATES PIPE LINE FRACTURES

Fluorescein, L.T., used to help rescue airmen forced down at sea, was applied to locating leaks and fractures in the Pluto cross-channel pipe lines toward the end of 1944. Fluorescein produces large colored patches on the sea's surface visible at great distances to patrolling aircraft or ships, so the British Petroleum Warfare Department thought that if the solution could be pumped through the damaged pipe it would reach the surface of the sea through the fracture, thus revealing the position of the damage. However, enormous quantities of fluorescein solution would be needed to color a sufficient amount of the sea's surface, as it would have to rise from the ocean floor. Experiments finally produced a solution of fluorescein that would rise to the surface without mixing with sea water and then spread over a large area.

NEW BRITISH PLANES

Britain had four new airplanes in production for the Japanese war that they claimed were faster than any warplanes yet produced. The jet-propelled Vampire, with a speed of more than 500 miles an hour in level flight, is a single-seat fighter designed and built by the makers of the Mosquito. The propeller-driven Hornet, officially described as a scaled-down version of the Mosquito, has a top speed of more than 470 miles an hour. The Spiteful, offspring of the Spitfire, is a single-seat fighter with streamlined fuselage and wings and a top speed of 460 miles an hour. The Lincoln, a mighty new 4-engined bomber, is bigger than its predecessor, the Lancaster, can carry a heavier bomb load, and has greater speed and range.

FLOTATION DEVICES

While Nazi Germany frantically sought a secret weapon to end the war with one blow, American Ordnance technicians quietly and steadily worked on various adaptations for battle-tested weapons—adaptations that contributed to shortening the conflict.

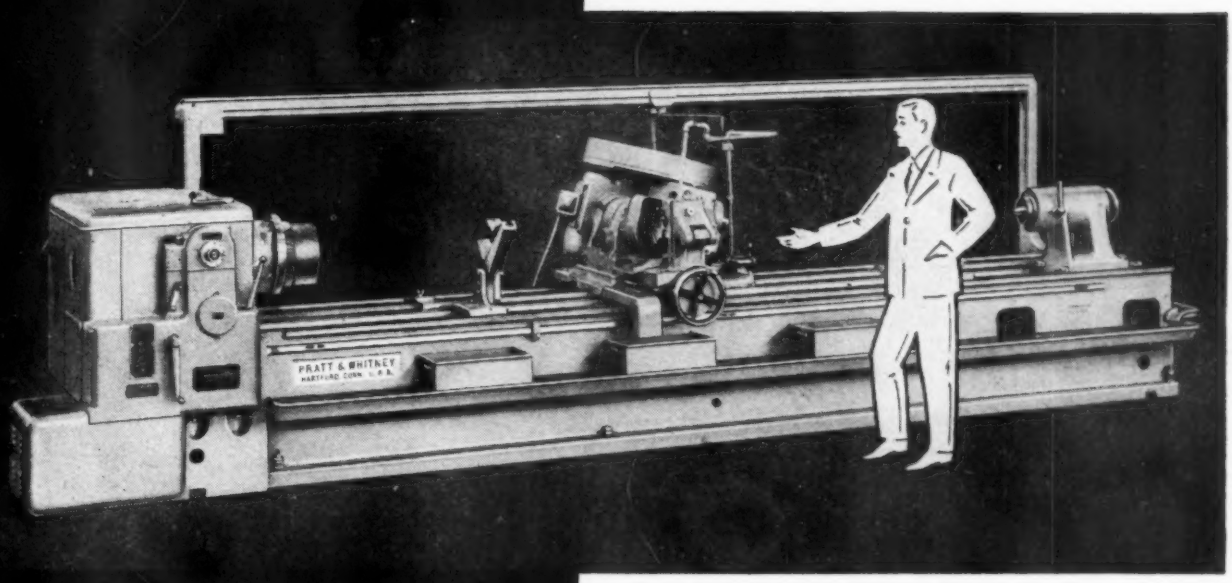
Details can now be disclosed of devices that played a vital part in the successful storming of beachheads and the crossing of river barriers previously considered invulnerable. They are flotation devices that enabled tanks to swim through miles of deep water.

After American Ordnancemen had successfully accomplished the wading and fording of combat vehicles—with tracks still keeping a solid footing on the ground under the water—they turned to the problem of developing a device to enable these vehicles to swim also. On the Russian front the Red Army once had to build an underwater bridge in order to assault a strongly fortified river bank successfully. With flotation devices, the American Army was able to accomplish the same type of job merely by swimming the tanks across rivers.

One class of flotation attachment was the rigid-pontoon type consisting of metal flotation cans fastened to the front, rear, and sides of the vehicles. Another was a boatlike canvas affair mounted on the tank above the tracks. The canvas could be raised or dropped in a short time and was supported by a framework of vertical rubber tubes and horizontal metal frames pneumatically controlled. Propulsion was aided by means of twin propellers, each driven from one of the track sprockets and raised and lowered by hydraulic controls.

The rigid-pontoon device can be jettisoned by a blow pin exploded by controls inside the vehicle. Propulsion was obtained

NEW!



P & W 12″ UNIVERSAL MODEL "C" THREAD MILLER

Here is Pratt & Whitney's brand new 12″ Universal Model "C" Thread Miller — a powerful, rugged machine suited for all types of thread milling up to 12″ work diameter.

This big machine is built to stand up under hard and continuous use . . . has ample power for cuts as deep as 1⅝″. . . yet the resulting threads are mirror smooth and accurate. The machine swings 27″ over the ways.

Forty work spindle speeds and sixteen cutter spindle speeds provide for a wide range. And in spite of its size, conveniently located controls make it easy to operate.

The machine illustrated is the longest available . . . has a center-to-center distance of 168″. The 12″ Model "C" is also available in sizes with center-to-center distances of 30″, 60″, 90″ and 120″. This newest addition to Pratt & Whitney's long line of machine tools will pay for itself many times over wherever it is used. Write us for complete information.

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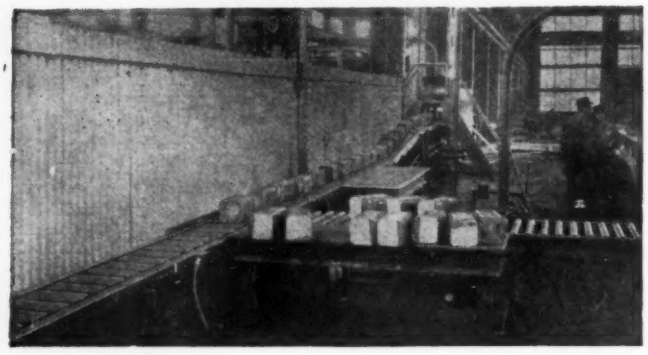
AN APRON FULL OF SHELLS FOR UNCLE SAM!



THIS Alvey-Ferguson *Apron* Conveyor installation carries billets from shearing machine to the furnace, where they are turned into rough forgings ready to be machined into shells.

Ruggedly built to withstand terrific wear, the aprons are made of channel carried on roller chains, with a cover angle over the top of the chains so that the top of the channel and the angle iron frame are flush. This makes it easy to slide the billets over the cover angle onto the channel aprons of the apron conveyor.

At various stages of production the conveyor carries the billets at elevations most convenient to the operators of the furnace, and various forging machines.

Whatever *your* material handling or product movement problem we can solve it with an A-F conveyor installation. Write, wire or phone, without obligation on your part for a consultation.

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CONVEYING EQUIPMENT
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METAL PRODUCTS CLEANING & FINISHING EQUIPMENT

New Developments

by tank tracks revolving through the water. Safety features included bilge pumps to expel water entering through leakage, wave action, or any other reason. This device permitted use of a tank's weapons during the trip to shore, while the canvas-type flotation arrangement did not.

By means of these features, heavily armored tanks or gun motor carriages could swim distances as far as four to five miles from an LST to establish a beachhead from the sea or traverse large rivers such as the Rhine. The rigid-pontoon type of flotation device was highly successful in the invasion of Okinawa, while the canvas arrangement saw heavy service in the invasions of Southern France and Normandy and in the crossing of the Rhine River.

ROCKET SUICIDE BOMBS

In the Okinawa campaign the Japanese made use of rocket-propelled suicide bombs against American forces. These weapons, similar to small single-seat airplanes, carry a pilot and are generally launched from the underside of the fuselage of a bomber. They have a wing span of about sixteen feet, a length of more than nineteen feet, and a tail plane of about eight feet. Constructed of light metals and wood, these bombs carry a heavy warhead of explosives. They are capable of high speed, but this reduces their maneuverability to a low point. United States forces designated these missiles as "baka bombs"—"baka" being the Japanese term for "stupid."

NEW FUEL DEVELOPED

A German scientist near the end of the war in Europe perfected a new fuel capable of producing a superheated steam. The Germans used this fuel for launching V-1 flying bombs and were planning other uses.

The fuel is called "ingolin." It is a high concentration of hydrogen peroxide in water and can be used as a fuel itself or as a source of stored oxygen. As a fuel, it produces a superheated steam which furnishes ready energy for driving pistons or turbines. The German inventor, a Doctor Walter, predicted that ingolin-powered naval torpedoes could develop three to four times their present range. With radio and other directional control, they could be made to cross and recross the path of an ocean convoy several times if they failed to make a hit on the first crossing, the German predicted.

Walter also stated that ingolin could provide an airplane with a speed of 650 miles an hour for 1 hour or 450 miles an hour for 3 hours. The Germans were experimenting with the use of ingolin as a medium for storing huge quantities of oxygen in submarines, thus allowing them to use their main engines when submerged Previously submarines have been forced to use electric motors when submerged or to employ breathing tubes.

INFORMATION FOR VETERANS

Veterans who want to know how to go about resuming their education, getting loans for a small business, farm, or home, drawing benefits, or who seek information regarding their court rights, income-tax requirements, or continuance of National Service Life Insurance, should get a copy of the revised booklet on "Information for Veterans of Our Armed Forces," recently published by the New England Mutual Life Insurance Company of Boston (501 Boylston Street, Boston 17, Mass.) and now available free to all veterans, including those still on active duty.

Honorably discharged Ordnancemen who wish to make connections with industry should write to the Ordnancemen's Professional Service of the Army Ordnance Association, 705 Mills Building, Washington 6, D. C. The purpose of this free service is to help Ordnancemen get reëstablished on a peacetime basis as quickly and as satisfactorily as possible. Full information is given on p. 377 of this issue.

Thanks

Much has been said and written about the wartime accomplishments of the steel industry—little or nothing about the work of the men of Army Ordnance without whose efforts and devotion to duty the job could not have been done so well or so soon... Gentlemen, our thanks!

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COMMUNICATIONS

PETROLEUM SHIPMENTS TO ETO

THE EDITOR.—In your Army Ordnance Bulletin No. 57 dated July 15, 1945, you make certain references to tonnages moved into European ports during the recent war with Germany. It is stated therein that "twelve per cent of all cargo was made up of vehicles and three per cent of gasoline and oil." The "three per cent gasoline and oil" was probably intended to be thirty per cent—perhaps your printer forgot the zero—as I will try to show.

About 6,000,000 long tons of petroleum fuel and lubricants went to northern Europe between D-day and V-E Day, about 4,000,000 tons of which was for U. S. forces. This does not include petroleum consumed in the British Isles nor that which entered Southern France prior to March 1945, which can be conservatively estimated at another 1,000,000 tons. This amounts to 24 per cent of your 21,411,899 tons of supplies of all kinds discharged in Europe since January 1942, part of which was presumably consumed in the British Isles.

LIEUT. COL. JAMES A. RICHARDSON, III
Ordnance Department

Area Petroleum Office, ETO.

■ **For a detailed analysis of the European petroleum supply during the recent conflict, see Colonel Richardson's article, "Petroleum at War," in this issue.**

BARRACKS BAG CARBINE

THE EDITOR.—Just want you to see what we do in our spare time and with matériel that was all scrap. Taking a regular M1 carbine which had been discarded by the small-arms section, I cut off the barrel to eleven inches, set up the barrel in my lathe, trued up the muzzle, turned down the barrel end to take the sight, and fitted same. Equipped with a "paratrooper stock," this arm now shoots as well as a new weapon, is accurate up to the same distances, and is much easier to carry around when working.

CORP. STUART W. HAVENS
887th Ordnance HAM Company

TRAINING FOR ARMY-NAVY ENGINEERS

THE EDITOR.—All commissions in the U. S. Army Engineers and in the Naval Construction Corps should be given to men selected as follows: At the age of 15, boys would be selected competitively by examination on an intellectual and physical basis as apprentices to serve seven years.

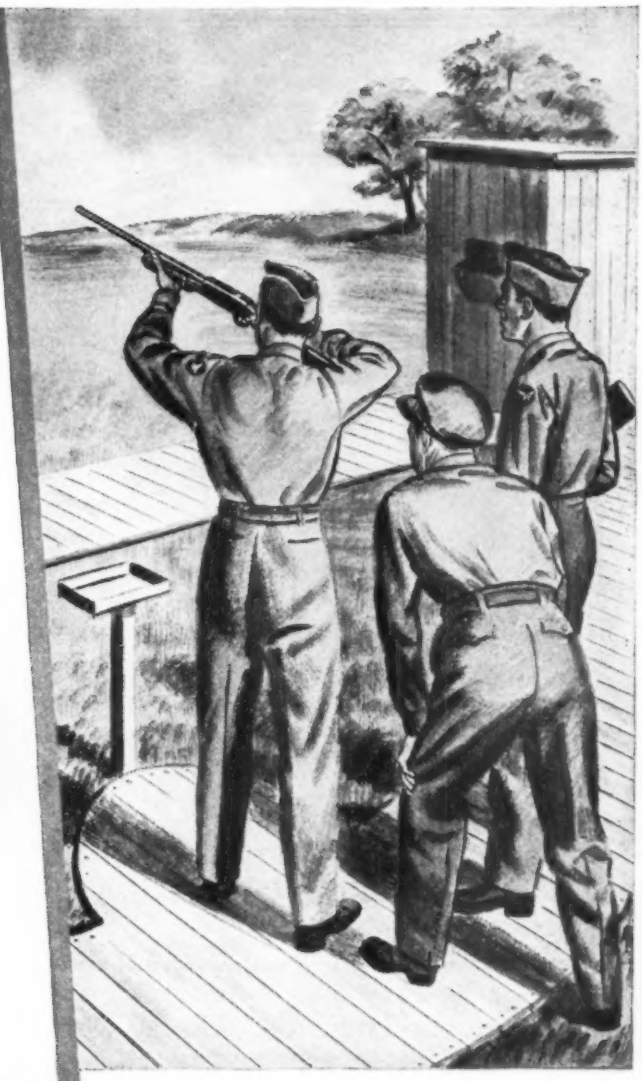
For the first 3½ years the apprentices would live at home. At the end of that time, a certain percentage would be selected by competitive examination for West Point and Annapolis.

Selected apprentices, after six months at West Point or Annapolis, would go to Massachusetts Institute of Technology or similar schools for four years.

The others would then go to military and naval establishments and complete their apprenticeship. The apprentices would serve seven years after their seven years in the Government service as enlisted men. The officers would serve ten years after graduation, and all would be subject to recall in the event of war.

S. M. UDALE
Detroit, Mich. *Holley Carburetor Company*

THE REMINGTON WONDER TRAP



MANY FIGHTER PILOTS and aerial gunners acknowledge their training in shooting clay targets contributed notably to their superior marksmanship in bringing down enemy planes. Sturdy, dependable Remington Wonder traps, like the one shown above, have thrown millions of clay "birds" for gunnery students learning to hit flying targets. The Remington Wonder trap has been used and strongly endorsed by shooters at all National Skeet Championships. It represents another reason why shooters say, "If It's Remington—It's Right!" Remington, the oldest manufacturer of firearms in the country, makes a complete line of equipment for clay target shooting.

Remington Electric Skeet Timer. The Remington Wonder trap can be supplied with this small, compact electric timer . . . eliminating manual operation. Instantaneous or variable timing may be had with the flip of a switch!

Remington DU PONT

BUY A VICTORY BOND — BRING THE BOYS HOME

REMINGTON "BLUE ROCK" CLAY TARGETS. Easy to see and easy to hit. Maximum speed of rotation and minimum breakage in transit and handling.

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REMINGTON "SHUR SHOT" shells have been used by the millions for aerial gunnery training purposes. Known the world over for uniform performance and their exclusive Kleanbore non-corrosive priming.

Wonder, Kleanbore and Blue Rock are Reg. U. S. Pat. Off. Shur Shot is a trade mark of Remington Arms Co., Inc., Bridgeport 2, Conn.

FRIENDS

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Mine Destroyers

Breaching Equipment That Aided Invasion

Lieut. L. R. Brock

THE problem of breaching mine fields was a very serious one in recent campaigns. In order to provide armor protection for personnel engaged in the breaching operation and to do the job more speedily, many types of mechanical equipment for mounting on tanks were investigated. The more successful designs fall into three categories: excavators, disk-type rollers, and flails. The mine excavator T5E3 is a combination of a scarifier and a snowplow for use in beach sands or cultivated areas.

The mine exploder T1E3 is of the disk type, clearing a path in front of each track. The disks are driven by chains and sprockets from the main drive sprockets of the tank.

The mine exploder T1E4 is of the disk type with each disk individually suspended through rubber torsion elements. This device affords complete coverage for the width of the vehicle and is readily steered through the use of a ball-and-socket attachment to the chassis assembly. This device was developed in conjunction with the Chrysler Corporation.

Many flail-type exploders were developed, some of which saw action in North Africa and Italy. The general type has been identified in the British "Scorpion."

Mine-resistant vehicles, designated T15, were developed for use as prime movers for mine-exploder equipment to provide additional protection for personnel from the possible use of coupled or delayed-action mines which might explode under the tracks or belly of the tank. Various pilots were developed from preliminary Ordnance drawings by the Chrysler Corporation and the York Safe and Lock Company.

A REQUIREMENT existed for a light mobile device for exploding antipersonnel mines in advance of infantry. The antipersonnel mine exploder T13 was developed, based on a modified M29 or "Weasel" with a lightweight multiple-drum exploder pushed in front of it. This device will not explode antitank mines but will explode antipersonnel mines and affords protection from fragments for the operator. The device was detailed and fabricated by the Leavenworth Steel Corporation.

Bulldozers have been developed for artillery tractors for use in the emplacement of guns, ammunition, and fire-control equipment and the preparation of revetments, as well as general ground clearing and road making. The bulldozer T1 was designed for the high-speed tractor M4, and the bulldozer T3 for the high-speed tractor M6. The maximum practical interchangeability of parts has been maintained in order to simplify maintenance in the field.

Tank bulldozers are already well known and have been used in practically every theater of operation for reducing obstacles and general bulldozing under fire. The bulldozer T7 has been developed for use on medium tanks of the M4 series incorporating all improvements indicated from experience with the earlier bulldozer M1. This type provides reduced interference with visibility and armament, is considerably lighter in weight, and is provided with a high-performance hydraulic system to improve greatly the operation of the equipment. The same design has been followed through with a maximum of interchangeability to apply to the light tank M24 and heavy tank M26.

Lieutenant Brock is assigned to the Development Division, Office, Chief of Ordnance—Detroit.

ARMY ORDNANCE

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

Founded 1920

Pledged to Scientific and Industrial Preparedness for Peace

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A word about the editorial policy of Army Ordnance Association publications is in order. The war is won, hostilities have ceased, censorship is relaxed. Many matters relating to our military situation can now be discussed which heretofore were forbidden either by the law of the land or the dictates of loyalty, security, and propriety. When at war there is but one objective: to win it. All energies are directed to that supreme end. Errors must be overlooked or treated lightly because to stress them at the time would do more harm than good.

ARMY ORDNANCE has stressed the achievement of American industry and the fighting forces at every turn. Generally speaking, theirs was a great job well done. But there were tragic mistakes in particular fields. Some can be laid to the nature of the emergency, others to lack of experience; some to plain stupidity, others to just plain cussedness.

On the industrial side, slowness to grasp the full import of modern war even when imminent was a notable error common to a vast portion of the fraternity. All the griping was not confined to the GI's.

But most of the mistakes were on the Government side. Some of the agencies were manned by visionaries whose contribution to victory would have been far more notable had they served for the duration as attendants—or inmates—in a psychiatric ward. Some military errors of judgment were equally tragic.

Hence our editorial function from now on will be served best by a frank and fearless consideration of these problems in the months and years to come. No greater service can be offered to our national security than to analyze, debate, and correct the mistakes of this war. Only in that way will we be able to overcome the pitfalls in another emergency. We must hold the mirror up to nature not as carping critic but as friend and counselor. The next war will be won or lost as America is true or false in its study of World War II.

—*The Editors*

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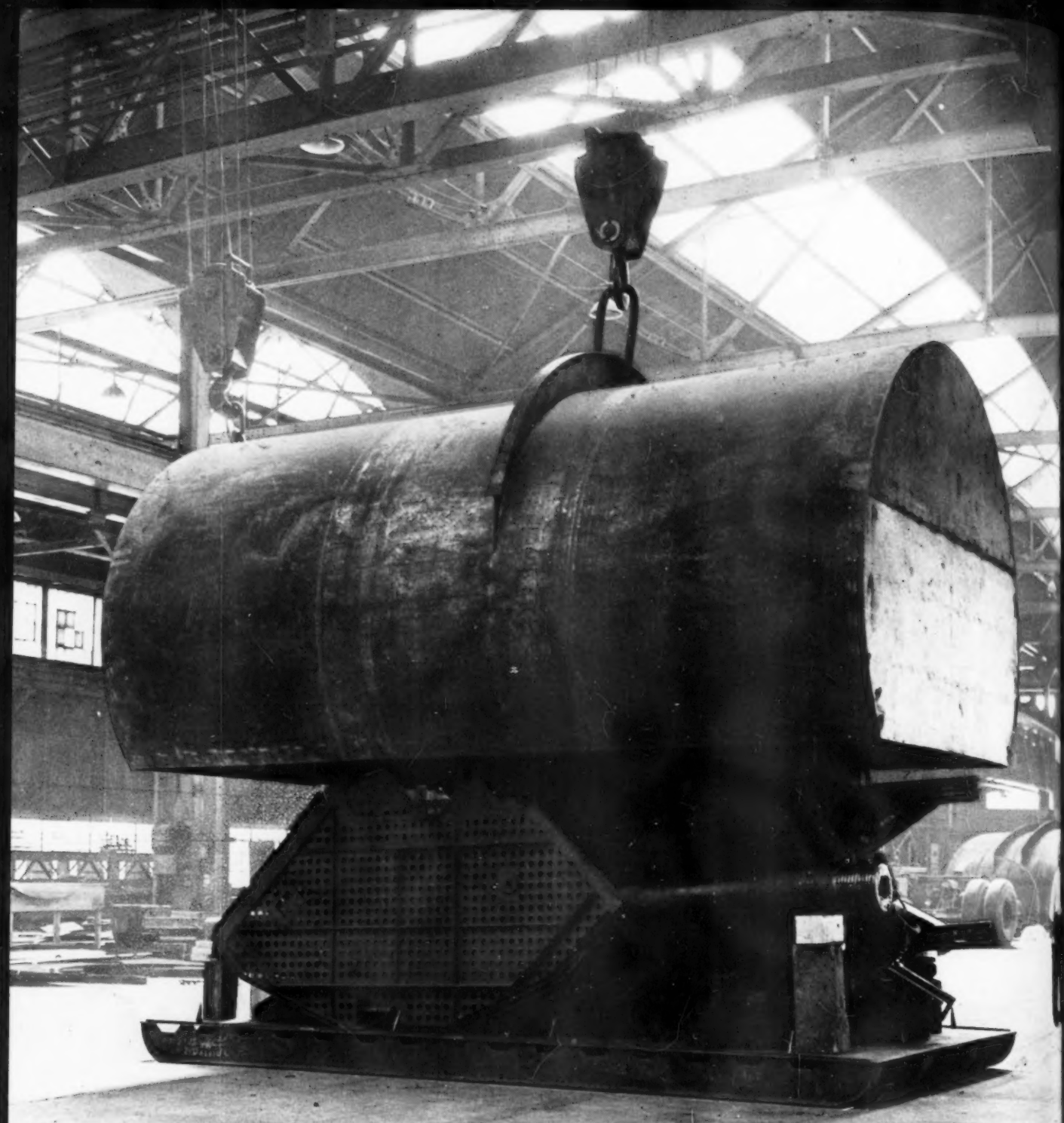


Canned

Firepower

Preparedness in the Atomic Age

The Wilson Plan for National Defense

THE atomic bomb has reduced the time factor of preparedness from months to minutes. Time has always been a crucial element in warfare. Since the dawn of creation battles have been won and lost by split seconds. Surprise —the priceless ingredient of victory— is primarily a matter of time. Hence, the atomic age, by reason of the instantaneous power at its command, brings with it an accelerated concept of readiness for war.

It behooves us to give serious thought now to the substance and form of our plans for future defense since obviously the old order of M(obilization)-day plus so many months in computing military requirements must give way to M-hour plus so many minutes.

In all the welter of proposals that have emerged for scientific and industrial preparedness we like best the one advanced by Charles E. Wilson, president of the General Electric Company, and sometime executive vice-chairman of the War Production Board. This plan was first announced to the members of the Army Ordnance Association at the twenty-fifth annual meeting of the society a year ago.

The Wilson proposal strives to bring about a realistic point of view toward preparedness. The tendency to war is inevitable, just as the human tendency to disease is inevitable. Because we do not have a "sickness economy" and a "health economy," neither should we have a "war economy" and a "peace economy." Mr. Wilson urges full preparedness according to a continuing plan.

"I am indebted to Mr. R. E. Gillmor, president of the Sperry Gyroscope Company and a Navy man himself," Mr. Wilson said, "for the pertinent observation that ever since the days of Mahan, our country has recognized the principle of a 'fleet in being' as an instrument of naval policy in both peace and war.

"What is more natural and more logical, in view of the increased mechanization of war and in view of the fact that the scientist and the mathematician are the ones who put our fighting planes in the sky and plant our shells in the hearts of enemy cities, than that we should henceforth mount our national policy upon the solid fact of an industrial capacity for war and a research capacity for war that is also 'in being.' It seems to me that anything less is foolhardy."

The Wilson plan in simplest terms comes down to this: Use existing facilities and bring together at some level the research activities of both civilian and service groups. Committees representing all these elements would be appointed by some such agency as the National Research Council for 3-year periods with one-third retiring each year.

CHARLES E. WILSON, president of the General Electric Company and a director of the Army Ordnance Association, typifies the best in American industry. In time of peace he and his company energetically advanced better living and greater comfort through the application of electrical energy. In time of war he came to the assistance of the Government as vice-chairman of the War Production Board. His company turned to the manufacture of weapons, using its vast power for quick and effective production. We salute Mr. Wilson as representative of that great group of American industrial leaders who helped so notably to win the war. His likeness on the front cover of this issue is the work of LeBarron Coakley, well-known illustrator in the Nation's Capital.

One of the responsibilities of a member of such a committee would be to keep his assigned institution in close liaison with industry and with Government laboratories. Such a group could formulate and recommend development contracts or research projects with various industrial or college laboratories wherever the best facilities presented themselves.

ON the production side, the Wilson proposal envisages representatives of all principal wartime producers from whom would be chosen an industrial coördinating committee to serve in conjunction with the principal procurement officers of the services. This committee would parallel the general research committee. Both would be permanent and continuing, although the personnel would change.

Here then would be a combined chiefs of staff group for research and production. Our military Combined Chiefs of Staff organization proved its worth in World War II beyond all estimate. So, it seems to us, would a scientific and industrial combined chiefs of staff setup give us the assurance of preparedness which will be so necessary in the years to come.

"It is my feeling," said Mr. Wilson, "that both branches of the service should keep their technical officers in closer touch with manufacturing plants through assigned tours of duty.

"As for Government-owned plants, some of these undoubtedly should be retained in stand-by condition for future use. But we must bear in mind that little is to be gained by reserving and maintaining huge plants for the production of highly specialized weapons and equipment, because they will almost certainly turn into the whitest of elephants.

"As long as warfare is global in character no man can foresee the nature of future weapons which tend to grow out of the demands of a particular theater of war. It would be preferable to authorize a steady flow of educational orders for small amounts of new equipment so that those companies which would have to swing into volume production might keep their hands in and be ready for expansion.

"I do not know, and it is not my place to advocate, whether or not we need a huge armament program. But the high importance of this plan of keeping scientifically and technologically ready for war lies in the fact that it does not involve the maintenance of large armed forces.

"Nor would this program be very expensive. It would not depend upon universal military service, although that offers many advantages, or upon large-scale production of military goods. It can fit into our peacetime way of living without difficulty. I believe with all my heart that it would *guarantee* that way of life."

School for Security

The Army Industrial College in Peace

Brig. Gen. Donald Armstrong

VICTORY in the late war cost the United States 250,000 dead, 650,000 wounded, and over $300,000,000,000. The intangible costs exceed all calculation. If, in return, there results an international organization that can maintain peace, the cost will be measurably compensated. Until we have ample evidence that this is so, we must demand other returns from the stupendous investment.

Victory alone is not sufficient. From the expenditure in life, in treasure, and in suffering we have a right and a duty to ask and to receive perpetual dividends. These dividends are to be paid in the immediate and long-range future in the form of continuing and improved teamwork between the armed forces and the civilian population of the country.

To this end those of us who are able must add to the already paid-in capital a further modicum of energy and thought that pales into insignificance in comparison with the original contribution. Nevertheless, such continuing vigilance on our part will help to wring out of the anguish of this war the possibility of preventing a recurrence of such a conflict. The gain to be derived must be our future national security.

If history repeats itself, we may expect that most of us will seek to forget the ordeal of battle as quickly as possible. It will be too great an effort to think further of the problems of war and peace. We shall note with complacency our great actual power as a nation. We shall think not at all of the rise and fall of civilizations that have preceded us. We shall be conscious that we are the strongest nation in the world today. But we should not forget that in 1918 France was the strongest nation on the Continent of Europe—and we should not forget what happened to that nation in June 1940. No nation has ever retained a place of primacy save by moral, physical, and intellectual stamina strong enough to win and keep it.

Our democracy has proved its virility by organizing the most productive war economy ever seen on earth. We cannot allow the cohesive compulsion of war to disintegrate into peacetime indifference; we cannot permit the isolation of the armed forces from the civilian elements of the country.

The purpose of these comments is to point out some ways and means to safeguard our strength by preventing such indifference and isolation. The way is the way of rational measures to preserve in the years to come the place we have won by an effort without parallel in our history. It is a measure of thought and planning that supplements the arms and the men in the Army and Navy.

The Army Industrial College is one of the most important agencies in which and through which this work can be carried out, with the coöperation of industry, labor, and the intellectual groups in our country and the assistance of such powerful organizations as the Army Ordnance Association.

Since, unfortunately, there is widespread ignorance concerning the Army Industrial College, its history and functions should be briefly described. The establishment of the college was an innovation in military history. When, at the instigation of a distinguished Ordnance officer, Maj. Gen. James H. Burns, the War Department organized the college in 1924 there was no precedent in any other Army in the world for an institution of this kind. Previously the effective employment of our national resources in war was not considered sufficiently complex or difficult to require the special training of officers concerned with this function. How unsound and incorrect was this belief was proved in 1917-1918.

The remedy for the imperfections in our first total industrial mobilization was the institution of this training school for military personnel. Under a succession of unusually competent and farsighted commandants, over 650 officers of the Regular Army were trained in the college before Pearl Harbor. Beginning in 1940, scores of Reserve officers graduated from five short courses that prepared them for the manifold duties in the mobilization of the economic resources of this country. Navy and Marine Corps officers have also been trained at the college.

THE Army Industrial College is now completing a temporary mission which it undertook on the orders of the former Under Secretary of War, Robert P. Patterson, in January 1944. More than 4,500 officers and civilians of the Army and Navy and civilians from many other Government agencies have been trained in industrial demobilization; *i.e.*, contract termination and disposal of surplus property.

The atomic bomb and other revolutionary weapons necessitate a revision of our thinking and planning concern-

THE Army Ordnance Association, long an outspoken proponent of the Army Industrial College, recently recommended its expansion to meet the problems arising from World War II. The Association's Committee on Industrial Preparedness with Col. William W. Coleman, vice-president of the Association, as chairman, and Col. Herbert A. Gidney of Pittsburgh and Col. A. W. Herrington of Indianapolis as members, made the following recommendation:

"As a minimum there should be provided for the industrial phase of our national defense in time of peace . . . an Industrial Mobilization College as the center of a system for the purpose of training, in all phases of industrial mobilization, Regular and Reserve officers of the armed services; responsible officials of the executive departments and independent offices of the National Government, the several States, and other important subdivisions of government; and selected civilians of American industry including capital, management, and labor. In the work of this college, particular attention should be paid to the study of the availability and distribution of resources which must be made to meet the needs of the armed services and the essential civilian requirements in war."

General Armstrong is commandant of the Army Industrial College.

ing industrial mobilization. The new weapons now demand the most effective contribution from the social, economic, and technological resources of this Nation. Moreover, if we are victims of future aggression, we shall probably be attacked without warning. Consequently, our mobilization will have to start faster, accelerate quicker, and finish stronger, if we are to survive.

THE obvious conclusion from these premises is that the Army, the Navy, and all elements in the military potential of this country must coöperate in time of peace far more closely than ever.

Since war integrates the national potential into a resultant of all its multitudinous forces, the resultant will be greater, will operate earlier and against fewer opposing forces if in time of peace there is a better understanding between the armed forces and the civilian community. This is particularly true of the members of the armed forces who are or will be assigned the duty of mobilizing, under civilian control, our economic potential.

The soldier and civilian must understand each other's point of view, the objectives, and the tools with which they reach the objectives. The civilian must keep the soldier informed concerning the changes in his tools and skills and the improvements that are made in them. The soldier must be trained and sufficiently intelligent to see in what way these new inventions or processes can be used to improve military equipment and methods.

The recent war taught us that time is needed to organize and orient the newly created civilian agencies which exercise supreme control of a war. This article is not concerned with questions of organization; yet the principle is sound that in war we should neither create a new organization nor reorganize but rather confine ourselves to the expansion of an existing organization. We must, through the Army Industrial College, educate a body of officers and civilians adequate in numbers and competent by training to operate the machinery of organization whatever it may be.

Since it is our thesis that time can no longer be bought to ward off a swift attack on this country, the college must greatly broaden its scope and purpose to meet the situation. We must study not only the economic background of war but we must be aware of its social, political, technological, and psychological aspects. Representatives of civilian activities of all sorts—governmental departments, labor, industry, the social sciences, and the scientific societies—must participate in the faculty and student body of the college and in its research in carrying out its mission. It is difficult to draw the line for the exclusion of any civilian activity, so completely does modern warfare affect the whole society of a nation. Admittedly this is a grandiose mission, but it is not chimerical in view of the facts.

Coördination of the military and the civilian elements is a most important goal of the college in the years ahead. Since a board of civilians and Army and Navy officers is now studying the question of a postwar joint educational system in the field of industrial mobilization, production, and closely related subjects, reference to the future curriculum will be limited. The personnel of this board is listed on this page.

The recommendations to be submitted by this board will include the change of name of the Army Industrial College to one that will indicate Navy and civilian participation in its work.

In applying the obvious lessons of the two World Wars, the commandant of the Army Industrial College advocates more extensive and more thorough training than was formerly offered. The proposal merely envisages such a number of years devoted to training for the mobilization and use of our national resources as are considered essential to train line officers.

An Infantry officer, on completing his course at the Infantry School, subsequently goes to Fort Leavenworth and finally to the War College to be adequately prepared for the strategic management of war. The management of war on the social and economic side requires at least an equivalent period of training. The conclusion is inevitable that with that objective there must be, in the future, increased and more purposeful training in this field. Therefore the recommendation is being made that the more basic and fundamental portions of the curriculum of the prewar Army Industrial College be transferred to a preliminary course of training, preferably to be given in a civilian institution.

This would follow, after some intervening years, the initial education of officers of the technical services in their own schools. This course would include the fundamentals of economics, statistics, accounting, factory organization and management, and other subjects essential for officers engaged in this work. If this were done and if subsequent to such a course its graduates were detailed to factories and headquarters of American industries, there would be assurance of sound, effective, and intelligent coöperation between industry and the armed forces.

SELECTED graduates of the course just described after some years would attend the Army Industrial College which would conduct its operations on the highest postgraduate level and devote far more time and energy to the study of the over-all management and use of our resources in war than has ever been devoted previously.

THE Army and industry are fortunate in having an advisory board of Army and Navy officers and civilians engaged in the study of "a postwar joint educational system in the field of industrial mobilization, production, and closely related subjects." The board consists of:

COMDR. JOHN W. HANCOCK, student of industrial preparedness and associate of Bernard M. Baruch;

O. E. HUNT, an official of the General Motors Corporation, Detroit;

LIONEL J. NOAH, formerly president of the American Woolen Company;

JOSEPH W. POWELL, formerly president of the U.S. Shipping Board, now Special Assistant to the Secretary of the Navy;

VICE ADM. WILLIAM S. FARBER, Subchief of Naval Operations;

REAR ADM. WILLIAM J. CARTER, Chief, Bureau of Supply and Accounts;

MAJ. GEN. E. M. POWERS, Assistant Chief of Air Staff, A-4;

BRIG. GEN. HUGH C. MINTON, Deputy Director of Matériel, Army Service Forces;

COMMODORE LEWIS L. STRAUSS, Special Assistant to the Secretary of the Navy;

BRIG. GEN. GORDON E. TEXTOR, War Department General Staff; Deputy Director, Special Planning Division;

BRIG. GEN. DONALD ARMSTRONG, Commandant of the Army Industrial College and recorder of the board.

The training just defined would develop capable administrators who know industry and the rules of management. On the other hand, the civilians who attended the Army Industrial College would become familiar with the organization and planning of the armed forces and would be prepared for the coöperative effort requisite for our national security.

INSTRUCTION in the college is now being supported and supplemented by its department of research established eighteen months ago. This department is headed by an Army officer but is composed almost exclusively of civilians who are specialists in their respective professions. These specialists have the advantage over the Army officer of studying uninterruptedly the use of our social and economic resources and the evaluation of similar resources of foreign countries. Their work does not end after a 4-year detail and the consequence should be the accumulation of basic data of much greater value than has previously been available.

The work of the college's department of research can best be understood if its organization and functions are examined in greater detail. The department is divided into nine research groups with the following responsibilities:

The man-power studies group investigates problems of population, man power, and its optimum use in the conduct of modern war. It is chiefly concerned with determining the supply and demand of men and skills needed for industry, agriculture, and the armed forces.

The foreign economic resources group explores the natural resources, industry, and other factors influencing the war potential of foreign nations. Members of the group also concentrate on the experiences in industrial mobilization of foreign countries in World War II.

The materials studies group is concerned with resources in raw materials, including agriculture and mining, and is particularly concerned with the commodities in which there are potential or actual shortages.

The industry studies group investigates the ability of each basic industry of the country to meet the demands of war mobilization.

The transportation, power, and communications group evaluates the necessary information on all forms of transportation and other public services, such as electric power, water, gas, radio, telephone, and telegraph. As in every other case, this group carefully notes economic and technological developments in each of these fields.

The civilian war agencies group conducts research into the war functions, organization, and methods of operation of the supervisory civilian war agencies and is particularly concerned with the relationship between the armed forces and these organizations.

The military requirements group studies general and specific matériel and personnel requirements for all branches of the armed forces.

The seminar studies group arranges conferences and discussions at which subjects in the field of industrial mobilization are carefully and systematically investigated. Transcripts of the meetings are verified and edited and are available in the department of research. Eighty such meetings were held during the first nine months of 1945, many at the request of other War Department agencies.

The historical studies group examines the experience of the United States, particularly in the late war, in mobilizing and administering a war economy. The analysis and interpretation of these data are of the utmost importance in the future planning of the Army-Navy Munitions Board and other staff groups.

The liaison office establishes and maintains communication between the department of research and other governmental agencies.

Other measures have been taken by the Army Industrial College to improve the teamwork of the armed forces and the civilian elements in the war potential. A board of advisers, comprising numerous distinguished citizens in industry, labor, social sciences, and scientific societies, has been started to aid and advise in all activities of the college. Meetings attended by these advisers, the staff of the college, interested officers of the Army and Navy, other governmental departments and agencies, and representatives of industry and labor are held frequently.

One of the most useful devices adopted about six months ago was the organization of advisory committees from the many civilian activities with which the college is associated. For example, committees are already at work representing the Iron and Steel Institute, the Machine Tool Builders' Association, the National Electrical Manufacturers' Association, the Antifriction Bearing Association, the Magnesium Association, the Social Science Research Council, and other groups. The mission of these advisory committees to the Army Industrial College is defined as follows:

1. To increase the mutual understanding between the armed services and all elements of the war potential of the United States. War potential includes natural resources and industrial facilities, utilities of all sorts, labor, and scientific and educational bodies.

2. To determine errors and deficiencies in mobilizing our war potential in World War II in order to develop and recommend policies and procedures for improving subsequent industrial-mobilization plans.

3. To keep the industry or other activity concerned constantly informed on War Department procurement policies and on probable military requirements.

4. To keep the armed services informed regarding the ability of each element of the war potential to meet military requirements. Depletion of natural resources and stock piling are particularly essential subjects of study under this heading.

5. To inform the armed services of technological developments and to educate the armed services on what they need or should need from the group represented. The Army Industrial College has the responsibility of applying social and technological progress to national defense. Industry should concern itself with advancing simplification and standardization in military specifications, to the end that mass production can be facilitated.

6. To assist in keeping the American citizen aware of the necessity of an adequate defense program.

The rôle of the Army Industrial College in a proposed program for strengthening teamwork in national defense has been sketched. A word of caution will conclude these comments. We who deal with the material side of war should bear in mind, for it is important in our work, Napoleon's remark that in war the moral is to the physical as three to one. Our national morale is of the utmost moment in the work of industrial mobilization.

Atomic Energy and the Future

Will the Next Conflict Be "The War of Pushbuttons"?

Dr. E. U. Condon

This article was written at the request of the editor of ARMY ORDNANCE by one of America's leading physicists who has been associated with nuclear physics since 1928 and was a member of the original National Defense Research Committee which recommended the large research program resulting in the development of the atomic bomb.

ON Monday, August 6, 1945, the first atomic bomb was dropped on Japan, and on Friday of that same week the Japanese Government signified its desire to accept our terms of surrender. Thereby the war was shortened by many months with the saving of probably at least a million lives and many billions of dollars. A weapon of such power has already brought the realization that the whole nature of warfare in the future will be as different even from that of the war just ended as the war just ended was different from the conflicts of a century earlier.

Indications are that the next war should be described as the War of the Pushbuttons. For the atomic bombs are such small and simple devices that it is easy to visualize agents of an enemy nation bringing them in in small pieces, under cover of diplomatic immunity, and assembling them quietly in the closets or back rooms of their embassies and consular offices in our chief cities.

Then when the decision to make war is reached, the ruler of the enemy nation has merely to say the word and his agents in our country touch off the dozen or two bombs so planted in each of our major cities. And within minutes the entire hearts of each of them are utterly destroyed—made to resemble the recently released photographs of Hiroshima. (See p. 395.)

With such a prospect before us we have no alternative but to arrange for a world organization with complete power to know what is being done everywhere. Fortunately there are signs that our political leaders realize the seriousness of the situation and are trying to use it to bring about a world union of peoples and an end to war.

Important as they are, such reflections are not, however, the main subject of this article. Its aim is to present briefly the scientific background of this development. At the outset it should be remarked that the full story is not yet released. The part of the story that can be told is given in the report by Prof. H. D. Smyth, recently made available in book form by the Princeton University Press. Smyth's story is so fascinating that it should be read carefully by every person with the slightest interest in the subject.

Since 1912, physicists have known that the atoms of which all matter is made consist of a central positively charged particle called the nucleus, which contains most of the mass of the atom, surrounded by enough electrons (negatively charged) to make the whole atom electrically neutral. Atoms of the different chemical elements differ both in the amount of the positive charge on the nucleus and therefore also in the number of electrons going around the nucleus outside it.

IN all the great science of chemistry the changes in matter are those which do not alter the nucleus. When ordinary chemical compounds are formed, as water from hydrogen and oxygen, the two atoms of hydrogen and one of oxygen come together in such a way that the electrons belonging to the atoms are shared. This sharing of electrons constitutes the chemical bond which holds chemical compounds together.

Nearly all the progress that was made in atomic physics from 1912 to 1930 was concerned with learning about the outer electronic structure of atoms. In this way we gained a complete understanding of the light emission by atoms and molecules and learned a great deal about fundamental chemistry.

The study of the properties of the central nucleus became known as nuclear physics. It really got under way about 1930. Earlier than that, most of the information known about the nucleus came from the study of naturally radioactive materials like radium, uranium, etc. Theoretical interpretation of the phenomenon of radioactivity in 1928 by Gurney and Condon and by Gamow provided a great incentive to such studies by indicating the possibility of disintegrating the nuclei of atoms of light elements by bombarding them with atomic ions which could be accelerated to high energies in high-voltage machines like the cyclotron of Lawrence and the electrostatic generator of Van de Graaff.

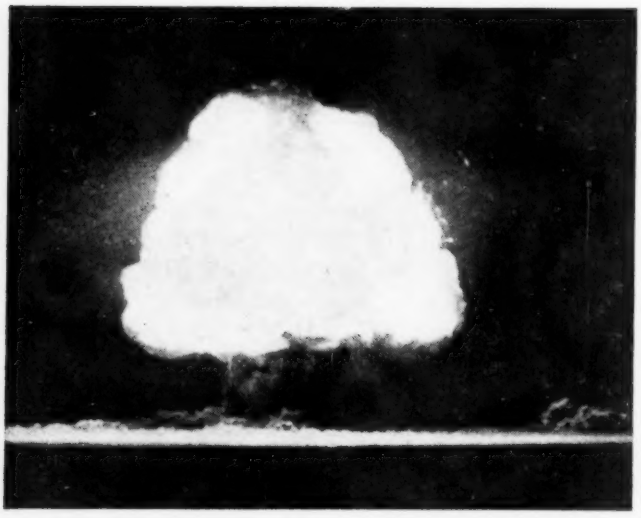
A rapid period of development ensued, marked especially by the discovery of the *neutron* by Chadwick in 1932 and of heavy hydrogen by Urey in the same year. The neutron is a particle having no electric charge (hence the name) and having a mass the same as that of the nucleus of the ordinary hydrogen atom, which in turn is called a *proton*. It is now believed that the nuclei of all other atoms consist of a close combination of protons and neutrons.

One of the most important problems of physics is that of learning about the strong forces which bind these particles together into stable nuclei. Only a little progress on this problem had been made when most fundamental research was stopped, and physicists devoted themselves to using what was already known to engineer the atomic bomb.

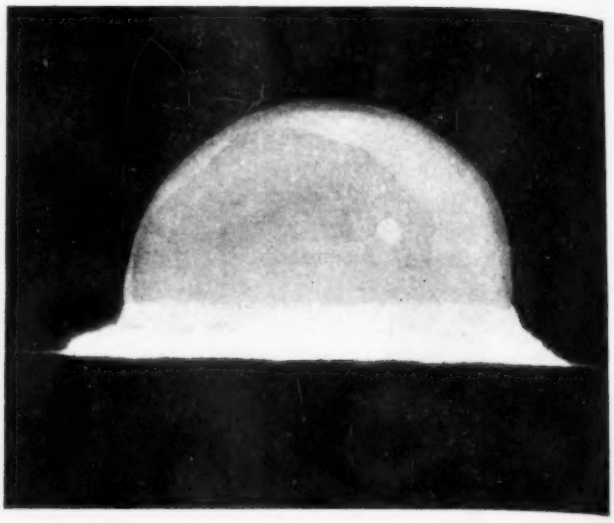
All the atoms of the same chemical element are therefore alike in the number of electrons outside the nucleus and of protons in the nucleus. But we find that the atoms of the same element may differ in the number of neutrons contained in the nucleus and hence in the whole atomic weight. About one in five thousand of hydrogen atoms has a nucleus consisting of a proton and a neutron stuck together. This is called heavy hydrogen. *(Continued on p. 396)*

Dr. Condon is associate director of research, Westinghouse Electric Corporation, and vice-president of the American Physical Society. He was one of a number of American scientists intimately connected with the development of the atomic bomb.

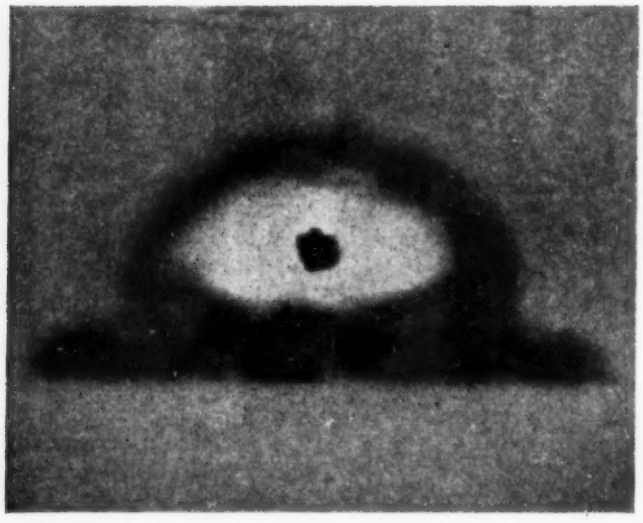
The Atomic Bubble of Death—



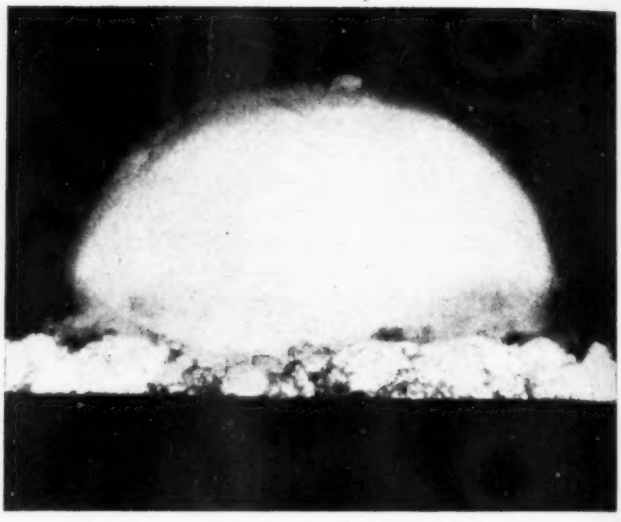
1. First atomic bomb explodes above New Mexican desert in test of new weapon. Other time-interval views follow.



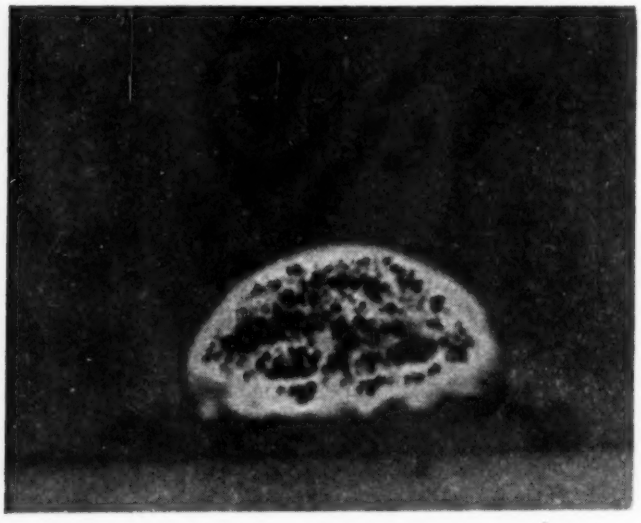
4. The bubble glows with the white-hot energy of atomic power. Sand of the desert was crystallized by the heat.



2. The blast spreads downward in an inverted cone. It knocked down observers nearly 6 miles from the test site.



5. The chain reaction is reaching its zenith and clouds of dust and smoke boil from the base of the blast area.

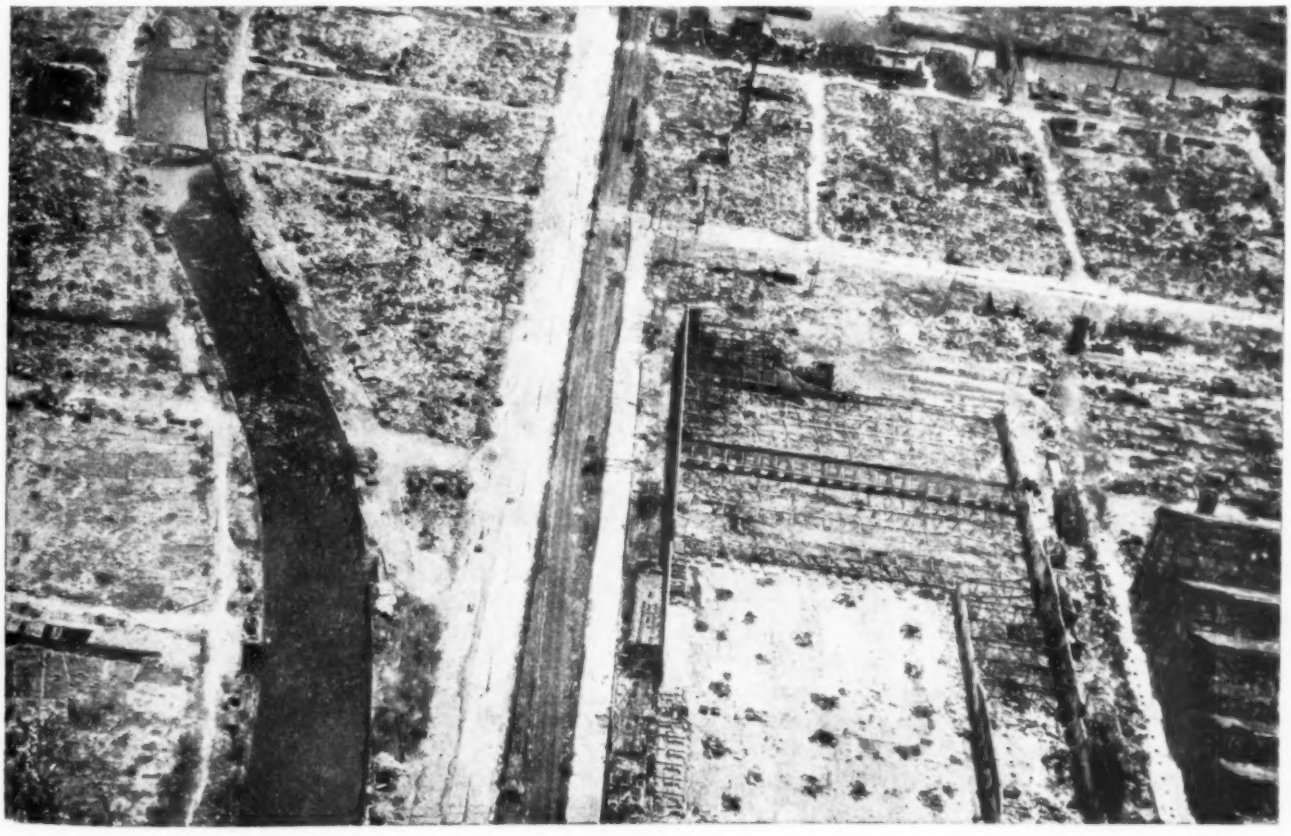


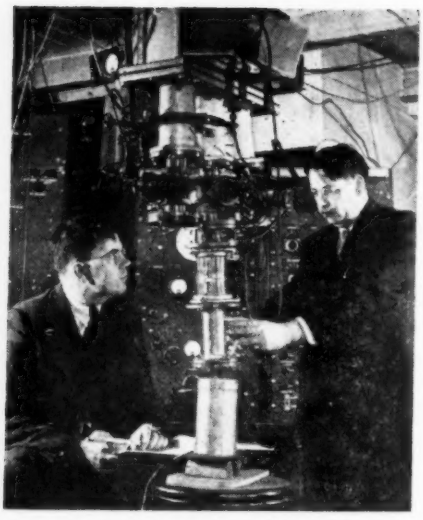
3. After the initial blast, chain reaction sets in, forming a bubble of death that seethes and grows ever larger.

6. As the bubble disintegrates, a pillar of smoke shoots 40,000 feet into the sky (International News photos).

That Wreaked Devastation on Japan

An allied war correspondent, above, stands in the rubble that was Hiroshima, one of Japan's key industrial cities, looking at the ruins of a theater. The city was hit with the first atomic bomb dropped from an American Superfortress. Aërial closeup of Nagasaki, below, shows extensive damage caused by the mighty blast of the second atomic bomb (Press Association photos).





Dr. E. U. Condon (left) and Dr. J. E. Hill, research physicist (right), at target end of the Westinghouse 90-ton atom smasher.

As another example it may be noted that all uranium has 92 protons in the nucleus, but there are two kinds of *isotopes,* one containing 143 neutrons giving an atomic weight of 235 and the other containing 146 neutrons giving an atomic weight of 238. Besides that there is a third variety, U^{234}, which occurs to the extent of about one in ten thousand uranium atoms.

During the period from 1932 to 1939, the study of changes in nuclei produced by bombarding matter with high-energy particles and with neutrons was intensively pursued in laboratories all over the world as the most active field of advance in physics. In December 1938, Hahn and Strassman in Berlin discovered that uranium atoms when struck by neutrons would sometimes split in half with the release of a large amount of energy per atom split. The amount, atom for atom, was about fifty million times as great as that released on oxidation of one carbon atom to a molecule of carbon dioxide, as in the burning of coal.

WHEN word of this discovery reached America in January 1939, physicists in many laboratories started to study it more carefully and to learn extra details. The important discovery was soon made that when the uranium atom splits apart not only is a lot of energy released but several more neutrons as well, which for the first time raised the possibility of a continued release of atomic energy. For the several more neutrons might cause more fissions of uranium which would release more neutrons which would cause more fissions. Such a progressive mechanism is known as a *chain reaction.*

Many physicists at once realized the possibility of making an explosive which, weight for weight, would release millions of times the energy released in our best explosives. Several of them made contact with President Roosevelt in the fall of 1939, and he appointed a committee headed by Dr. L. J. Briggs of the National Bureau of Standards to look into the situation. This resulted in some Government support for research and further study which by the fall of 1941 had led to a fairly clear picture of the means necessary for accomplishing the making of the atomic bomb.

In the fall of 1941 the atomic bomb seemed to be a highly probable possibility, but no one could say that it was a certainty, and it was clear that a vast expenditure of man power and materials would have to be gambled on the venture to give it a fair trial. After many months of careful study a policy of greatly increased research effort was decided on in January 1942.

THIS was so successful by the summer of 1942 that it was decided to transfer the activity from Dr. Vannevar Bush's Office of Scientific Research and Development to a special unit of the U. S. Army Corps of Engineers. Thus there came into being the now famous "Manhattan District" of the Corps of Engineers, under the command of Maj. Gen. L. R. Groves.

Continuing the chronological outline, by January 1943 the sites had been selected for the two major manufacturing plants at Oak Ridge, Tenn., and Hanford, Wash., and the bomb research laboratory at Los Alamos, N. M., and all were under construction. By the summer of 1944 the plants were turning out products so that the bomb-research laboratory had material with which to work.

On July 16, 1945, the historic test of the bomb was made near Alamogordo, N. M., in time for the results to be communicated to President Truman at the Potsdam Conference. Within three weeks, Japan had felt the first blow and within less than a month had offered to surrender.

Returning to our brief outline of the technical story, research had shown that a bomb was only possible with essentially pure U^{235}, the rare isotope which in nature only makes up 0.7 per cent of the natural mixture with U^{238}. This is due to the fact that U^{238} absorbs neutrons in ways which do not result in fission, and this stops the chain reaction needed for the explosion.

But it had already been learned that when U^{238} absorbs neutrons in this way it forms a radioactive isotope U^{239} which disintegrates into a hitherto unknown chemical element, called neptunium, and that this in turn disintegrates into another hitherto unknown chemical element, called plutonium. The importance of these details consists in the fact that plutonium was found also to be a suitable material for manufacture of a bomb.

Although it was quickly realized that no explosive reaction was possible with the natural mixture of U^{235} and U^{238}, still a way was found in which the chain reaction could be kept going in a non-explosive way. This is done by an arrangement now called a *pile,* in which lumps of uranium are distributed throughout an otherwise solid pile of graphite. When this is done properly the chain reaction based on fission of U^{235} can be made to be self-maintaining, and some of the neutrons produced are utilized to convert part of the U^{238} into plutonium. This, being a different chemical element, can be separated from the uranium by chemical methods.

The process is greatly complicated in practice by the fact that the pile becomes so intensely radioactive that no one can go near it; hence it must be operated with remote-control mechanisms of a high degree of reliability. The plant at Hanford exploits this process.

The separation of U^{235} from U^{238} proved to be an exceedingly difficult and elaborate process. In order to be sure of success, several alternative methods were developed all the way to production. The mass-spectrograph method was developed at the University of California, the diffusion method at Columbia University, and the thermal-diffusion method at the Naval Research Laboratory. In the end, all three methods proved to be successful.

The kind of plant which was built for the production of plutonium can also be adapted to the production of atomic power for peacetime power purposes.

We are just beginning to learn this field and it is quite impossible to predict in what way discoveries made in the next few years may completely alter the limitations inherent in the picture as we see it today.

Tax Amortization

The Law Facilitated Industrial Expansion for Victory

Robert P. Patterson

Just at the time when increased industrial facilities were needed to meet the peril of war, national tax policy threatened to prevent a company from accumulating enough surplus to absorb that portion of the cost of the facilities which would remain unabsorbed at the cessation of war production. The Tax Amortization Law of October 8, 1940, gave the manufacturer the necessary protection from bankruptcy.

WARS are often lost before the first shot is fired. Fortunately, enough Americans realized this in October 1940. Although the national peril was great, we were not at war. We were witnessing the tragic consequences of "too little and too late." Our Army was woefully small, and we were lacking in facilities capable of producing the vast quantities of munitions that would be required. Immediate action was needed to avert the fate of other unprepared nations.

Private industry was naturally reluctant to risk its funds in the creation of war facilities. Contractors had to take into account not only the prospect of greatly increased taxes but also the existence of a tax law designed to limit war profits. This was the Vinson-Trammel Act, which had originally limited profits on naval and aircraft construction to twelve per cent. At the moment when a great facilities expansion became necessary, it was amended to limit profits to eight per cent.

Tax policy threatened to prevent a company accumulating enough surplus to absorb that portion of the cost of facilities which remained unabsorbed at the cessation of war production. Patriotism could not reasonably be expected to induce a contractor to court bankruptcy by tying up a large portion of his capital, much of it borrowed, in factory expansion which might suddenly become almost valueless. Some means had to be devised to allow the return of the cost of factory expansion to the contractor while the expanded facility was being used in war production.

The proposal was accordingly made to permit the deduction, for tax purposes, of the entire cost of a facility during the period of probable use for defense purposes. This period was set at five years, with a provision for shortening it should the national emergency prove briefer than expected.

This proposal, together with the provisions for an excess-profits tax and for the suspension of the profit-limitation of the Vinson-Trammel Act, was incorporated in an amortization law passed by Congress and approved on October 8, 1940. It became Section 124 of the Internal Revenue Code (Public Law 801, Seventy-sixth Congress).

Amortization was provided by the issuance of certificates by the Advisory Commission to the Council of National Defense and either the Secretary of War or the Secretary of the Navy. These certificates may be described as follows:

Necessity Certificates.—For facilities acquired or constructed after June 10, 1940, which were certified as necessary in the interest of national defense, an annual deduction of twenty per cent of the cost could be taken at the election of the taxpayer.

Certificates of Nonreimbursement and Government Protection.—By the terms of subsection (i), the twenty per cent amortization deduction was allowed only when the contract offered no direct or indirect reimbursement in excess of normal exhaustion and wear and tear, unless the contract which accorded such reimbursement also protected the interest of the Government in the future use and disposition of the facility. The fact that no reimbursement had been offered was to be established by a certificate of nonreimbursement. Adequate protection of Government interest was to be established by a certificate of Government protection.

Nonnecessity Certificates and Payment Certificates.—As provided by the act, these certificates were concerned with the termination of the use of facilities to which a necessity certificate had been issued.

The law was amended on several occasions as defects in its structure became evident. The most important amendments dealt with the authority to certify and with the troublesome subsection (i).

Joint Certification.—The requirement that necessity certificates be approved by the Advisory Commission to the Council of National Defense and either the War or Navy Departments soon gave rise to the usual problems resulting from divided authority. Delays in administration became serious. The armed services therefore asked to be relieved of all responsibility or given complete responsibility. Congress decided on the latter course, and, by an amendment of October 30, 1941, terminated the certifying authority of the Advisory Commission.

Nonreimbursement and Government Protection.—In the absence of a certificate of nonreimbursement or a certificate of Government protection, amortization rights under a Necessity Certificate were not established. To establish them, every contract of a necessity certificate holder had to be examined with reference to every facility covered in its certificate to make sure there was no reimbursement greater than normal depreciation.

THIS was an almost impossible administrative task. It was also extremely difficult to establish standards for protection of the Government's interest. Very few certificates of nonreimbursement and Government protection were issued. As a consequence, contractors hesitated, and the flow of private capital into plant expansions lagged.

This was the situation on December 7, 1941. Faced with tremendous demands for expansion, the War and Navy Departments proposed to Congress the repeal of subsection (i) in the belief that sound contracting could

Mr. Patterson is the United States Secretary of War.

achieve the desired protection. On February 5, 1942, Congress repealed subsection (i). The most serious obstacles to the administration of the Amortization Law were removed.

On October 15, 1940, the Secretary of War delegated to the Assistant Secretary of War (later Under Secretary of War) the duty of considering and acting upon the certificates which the act empowered the Secretary to issue.

A unit was established in the Office of the Assistant Secretary of War to administer the War Department's responsibility under the act. It was not formalized until Samuel S. Duryee became its chief in December 1940. Lieut. Col. (now Brig. Gen.) Edward S. Greenbaum became acting chief in March 1941 and carried this responsibility along with his other duties until January 1942.

Lieut. Col. (now Col.) George H. Foster then became chief and held the position until the work was completed in 1944. The unit was assisted by an advisory board composed of James P. Baxter, III, Mr. Duryee, W. Tudor Gardiner, Garrard Glenn, James Hall, F. H. Hurdman, Bernard Knollenberg, James M. Landis, Harold F. Linder, William L. Marbury, Abbot P. Mills, Dave H. Morris, Jr., Charles H. Murchison, George S. Olive, and Frederick F. Umhey.

War Department interpretation of the law, based upon regulations drawn up by a 3-man committee representing the War and Navy Departments and the War Production Board, did not cling to hard and fast rules, except in matters of procedure, but tried to discover whether the expansion under consideration was necessary to national defense because of the character of the items it produced and because of shortage in existing capacity for producing them.

IN the beginning it was evident that tanks, planes, guns, and ships would be demanded in quantities far beyond the existing fabricating capacity of the country. Shortly it became apparent that additional basic steel capacity was necessary.

This in turn required more coke ovens for coke, more coal for coke, more iron ore, more mining facilities, and more transportation facilities to move the ore, coal, coke, and steel to places of usefulness. Workmen had to be transported to and from work or housed at places of employment. Applications for the certification of transportation facilities, war housing, and cafeteria facilities were presented for decision.

In determining what facilities were necessary, the decision was sometimes relatively simple. Thus there was no doubt that a machine-gun plant ought to be certified, provided that Ordnance reported, after investigation, that the plant was necessary; and there was little doubt that movie theaters and facilities for providing soft drinks for war workers ought not to be certified. But there were cases in between these extremes which required much study and administrative common sense before it could be determined whether a particular expansion was really necessary to the national defense.

In determining the need for facilities it was necessary to consider not only the immediate contract commitment but the place of the request in the over-all picture of expansion, priorities, contract distribution, and other problems and policies. When a decision was finally made it represented an investigation of the industrial consequences which might spring from it.

The cost of a facility was generally considered a matter for the discretion of the applicant, as was the source of funds with which it was to be purchased. However, expenditures for luxury items or those to give permanency to a facility were denied, although a company might receive a certificate for larger property than it needed if it was the only property available.

Applications for the purchase of property hitherto under lease were not granted if it was feasible to continue the lease. Purchases between related persons or interlocking companies were ordinarily denied. The purchase of second-hand facilities was generally certified only where the purchase increased the usefulness of the facility for defense purposes or prevented a deterioration of its existing usefulness. Thus the purchase of used freight cars by one railroad from another was refused, but the purchase of a textile factory which was going to be junked was approved.

While many large expansions were certified, it may be said that, in general, the costs of facilities covered by any one application were in relatively small amounts. Big-scale financing was often handled direct by the War Department or Defense Plant Corporation.

BY the spring of 1943 it was becoming apparent that the great problem of expansion of facilities had been largely solved. Man power, rather than facilities, became the chief limiting factor in war production. Up to that point the construction of facilities had required almost as much effort as the actual production of munitions. Maximum production now required a sharp curb on expansion of facilities and the channeling of men and materials into direct production.

The question as to what extent amortization might now be curtailed was presented for decision to the Director of War Mobilization. On October 5, 1943, a stringent amendment to the regulations was adopted which limited amortization to facilities necessary for military or naval use and only after consideration of the possibility of Government financing. It was necessary also to have the facility certified as necessary before the expansion was started.

In spite of this amended regulation, the War Department was kept under heavy pressure, especially from the Office of Defense Transportation, to certify facilities for purposes not directly military. The War Department, therefore, on November 1, 1943, suggested to the Director of War Mobilization that if certification was to be granted in such cases it ought to be done by the War Production Board. Accordingly, on December 17, 1943, the President, by Executive order, transferred the certification authority from the War and Navy Departments to the War Production Board.

During the period of War Department responsibility, 31,047 applications for necessity certificates were filed with the Department and 26,775 were issued covering all or part of the application. The total dollar value of the facilities certified was $4,955,813,760. The Ordnance Department played a large part in this program.

The private manufacturer, however, could not be asked to undertake the rapid expansion which national defense required unless he were given reasonable protection against bankruptcy at the end of the effort. The Tax Amortization Law gave him that protection.

AAF

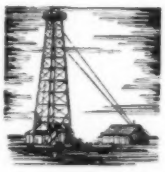
Patton said, "To hell with rations, give me gasoline"

Lieut. Col. James A. Richardson, III

THAT the modern army marches on petroleum was clearly expressed by Gen. George S. Patton, Jr., after the historic march of his Third U. S. Army through Paris and beyond when he said, "Give me gasoline, to hell with rations."

And so, missing a meal or two, his hardy men roared another hundred miles into Germany. General Patton's inference was that a modern mechanized army can continue to fight for a number of days without food, but not for a single day without gasoline.

One of the biggest supply jobs of this war was that of provisioning the fighting forces with petroleum fuel and lubricants. Large quantities of petroleum were consumed in transportation to the theaters of war. Ships carrying men and supplies over the seven seas were powered with petroleum fuel oil. Aircraft operated by the Air Transport Command flew over air routes that girdled the earth. Garrison forces throughout the world operated bases and kept supply routes open. Naval ships covered the sea lanes hunting submarines and protecting convoys. Allied nations required petroleum so that they could carry out their part in helping to win the war.



All these activities consumed their share of petroleum, but all were geared to the one objective in Europe: the build-up and supply of a military force sufficient to invade Axis-held Europe and to crush and destroy the German Army, Navy, and Air Force.

When the plan to invade Europe was originally agreed upon in 1942, arrangements were made for the build-up of a "pool" of petroleum fuel and lubricants in the United Kingdom sufficient to guarantee success of a large-scale invasion of northern Europe. This pool of oil was in custody of the British Government, but about sixty per cent of it originated from U.S.-controlled sources; the remainder came from British sources, mainly the Caribbean area and the Middle East.

By D-day, June 6, 1944, this war pool of petroleum products, mostly aviation, motor, and naval fuels and lubricants, consisted of over 7,000,000 long tons. This was sufficient to guarantee the wartime economy in the United Kingdom and to give the allied land, sea, and air forces in the European Theater an uninterrupted supply of petroleum under any conceivable contingencies of war.

By June 6, 1944, a pool of over 7,000,000 long tons of aviation, motor, and naval fuels and lubricants had been stored up in the United Kingdom—an amount sufficient to guarantee the allied forces in the European Theater an uninterrupted supply of petroleum.

To give flexibility to this vast stock of petroleum, the U.K. was threaded with over 1,000 miles of oil pipe lines between storage, receiving and shipping points, and inland airfields. These were laid by the British who already had plans for the "PLUTO" pipe lines across the English Channel to France.

DURING the beach landings in Normandy, the spearhead forces carried their fuel with them in 5-gallon steel cans known as "blitz cans," and aviation, motor, and Diesel fuels were moved

Colonel Richardson, during the European War, was assigned to the Petroleum Liaison Office of the European Theater of Operations.

Aviation gasoline (100-octane)	15.5%
Motor gasoline (80-octane)	65.0%
Diesel fuel	8.1%
Kerosene and distillates	1.3%
Fuel oil	5.2%
Lubricating oils and greases (less aviation lubricants)	4.9%
Total	100.0%

Petroleum products shipped to Europe.

ashore in these cans in ever-increasing quantities over "Omaha" and "Utah" beaches.

But the most economical method of transporting petroleum fuel is in bulk, and U.S. Engineer troops were already erecting oil-storage tanks ashore and began the construction of inland pipe lines, so that the first coastal tank ship of gasoline was able to discharge her bulk cargo ashore in Normandy on June 23, 1944, only seventeen days after D-day.

Thereafter, 4-inch and 6-inch fuel pipe lines followed our armies across France and finally into Germany. These pipe lines were fed by coastal tank ships from the United Kingdom and large ocean-going tankers direct from the United States, unloading at the European ports which had been cleared of mines and repaired by the Navy and Army Engineers.

In all, four pipe-line systems were constructed by the military pipe-line service of the Corps of Engineers. The minor system, from Port en Bessen, was constructed to supply the Normandy operations and was discontinued after the deepwater port at Cherbourg was opened. The major system began at Cherbourg and extended eventually beyond Paris to the Rhine. The southern system followed the forces from southern France up into southern Germany, while the northern system from the port at Antwerp extended to the rear of the American forces at the northern end of the front.

From the pipe head, or end of the line, as well as at intermediate stations, motor and aviation gasoline and Diesel fuel were "decanted" into 5-gallon blitz cans and shuttled to army fuel dumps or carried farther in tank trucks or railway tank cars to other locations and to airfields.

The pipe-line system, however efficient, did not always carry the necessary amount of fuel needed at the front. Tank trucks and cargo trucks also carried gasoline at high speed over the famous Red Ball express highway to the front, and occasionally gasoline was flown to the front from the United Kingdom in transport aircraft and bombers.

The underchannel pipe-line system called "PLUTO" was a minor part of the cross-channel supply setup because of its limited capacity of about 27,000 barrels (3,000 tons) a day, or about 13 per cent of the maximum imports for U.S. forces. However, this cross-channel pipe-line system was definitely successful and would haye been invaluable if the allies did not have complete air superiority over the Channel.

A brief review of the logistics of the Continental military operations from D-day until V-E Day shows the important part petroleum played in the defeat of Germany. The total supplies for U.S. forces moved to the Continent of Europe during this period amounted to approximately 19,000,000 long tons, including all types of cargo (except vehicles) and bulk petroleum.

About 4,600,000 long tons, or twenty-four per cent of this, consisted of aviation, motor, and Diesel fuels, and the common lubricants. This figure does not include the approximately 2,400,000 long tons of aviation fuel consumed by the U.S. Strategic Air Forces stationed in England but actually operating over Europe during this period. The petroleum shipped to Europe can be broken down approximately as shown in the table on this page.

THE consumption of motor gasoline on the Continent was over four times that of any other petroleum product because the operations were predominantly field operations involving automotive trucks and tanks. However, for the entire theater, including the United Kingdom, there were nearly equal proportions of aviation and motor gasolines consumed during the 11-month period. This was due to the heavy consumption of aviation gasoline by the U.S. Air Forces based in England.

The abundant supply of petroleum for the allied forces contributed to the success of the invasion of Europe just as much as the shortage of fuel in Germany affected the early defeat of the German Army. General von Rundstedt, after his capture, admitted that lack of air support was the primary cause of the early defeat of his armies. That so many German fighter planes were destroyed on the ground was due less to lack of trained pilots than to the fact that there was insufficient fuel to keep them constantly in the air.

THE famous raid on the oil refineries at Ploesti in Rumania had shown what havoc can be wrought on oil refineries by aërial bombardment, and it was determined that oil-producing plants and storage installations within German-held territory would be highest priority targets for destruction by the allied strategic air forces in England.

The campaign to destroy Germany's oil facilities began in earnest about a month before D-day and was continued throughout the operations so that by April 1945 Germany's oil production had been reduced to five to ten per cent of the figures before D-day. This was largely due to aërial bombardment of communications and facilities.

A great deal of credit for the success of the supply of petroleum to the allied forces in Europe is due to the keen foresight of Lieut. Gen. John C. H. Lee, Commanding General, Communications Zone, and to the sympathetic coöperation of the British War Office. General Lee kept in close personal touch with petroleum supply during the build-up stage in the United Kingdom and throughout the Continental operations. This was done through the Area Petroleum Office, under Col. Elmer E. Barnes.

On the Continent the receipt and internal distribution of petroleum was arranged between British and U.S. forces by an organization of British and American officers in Supreme Headquarters. U.S. operations on the Continent were controlled by Col. Freeman Burford from the G-4 Section of Communications Zone headquarters.

Signal Corps

Filling "blitz cans" from tank trucks.

AAF

An American Businessman Looks at War

Albert J. Weatherhead, Jr.

DURING the 45 days and 3,000 miles of my jeep trip through Germany I saw a lot, worked a lot, and wondered a lot. Readers of ARMY ORDNANCE may be interested in observations seen through civilian eyes and in the reactions experienced by an American businessman.

The traces I saw in Europe of the power of our superior Air Forces are awesome to behold. These traces, despite their deathly terribleness, are thrilling. But they make you thank God you are on the allied team.

It seemed almost incredible to me that this devastation could be a part of our twentieth-century civilization. But later, as our group progressed from one target city to another on our tour of German industrial might—Stuttgart, Frankfort, Mannheim, Cologne, Solingen, Munich—it became commonplace to see leveled buildings and mountainous ranges of rubble. That is all that remains of the industrial area of Germany's larger and most important cities.

Germany seems dead today, especially the big cities and towns. Few people are abroad on the streets during most of the day. The only time one sees more than a handful of Germans is at rationing time when they queue up for their small allowance of food. A few industrial plants in Germany are intact. These are small concerns employing a force of about 200 people. But not a wheel turns in these places.

The chief reason why German cities and towns are so void of life is that practically every citizen who breathes is working in the fields to produce food for the German nation. Old men, women of all ages, sober-faced youngsters—even incredibly young toddlers—can be seen dotting the wide areas of beautifully cultivated German soil.

THE term "defeated Germany" is a fallacious one. The German people have been conquered, but they are not defeated. They are licked physically but not mentally. Today in Germany I don't believe there lives one single German citizen who draws a defeated breath. And though they are slow to admit it, most Germans believe that Hitler is dead but that his spirit lives on. Their attitude of undefeatability will always, I think, cause them to want to incorporate other nations into their own, to pattern other nations' peoples after themselves, for dominance within a bigger German state.

The existence of strong Nazi underground operations electrifies the air of Germany today, and there is nothing any one can do about it. At one time the underground issued an order for citizens to counter our Army's former nonfraternization rule, which they resented terribly, with a freeze attitude of their own. As the Germans passed you on the street, their faces were set with blank, vacant looks carrying absolutely no recognition of your existence. They outstared and out-nonfraternized us. They always walk very fast, as if they have a definite purpose behind their haste. I believe they have one—a serious one—the purpose of getting geared all over again, as quickly as possible.

Credit is due to the German mind for its will to progress and to do everything the best possible way. These are German characteristics which will always be as alive as the attitude of hate, sadism, and unrest that exists in the belt of Europe in which that nation is centered. The allied nations and their peoples should realize that they will always have to station trustful watchdogs around Germany to guard against the trouble the unshakable aspirations of the German nation will always stir up. Many times while over there, I asked German citizens if they thought there would be another war. The answer was always a short "Ja."

That is their attitude—eagerness for war. It's one of their unshakable aspirations—the desire to conquer. I do not believe that reëducation of German peoples by allied tutors could produce any difference in this stolid German attitude. I don't believe any one can do anything about the German frame of mind. It is a stubborn wall that harbors a fierce homeland feeling, born of hatred and disrespect of the very existence of peoples other than themselves. To hope or accept their word that they will not again wage war would be utterly foolish.

Coupled with the homeland attitude is the danger of Germany's pride and love of industrial productiveness. These people have great minds for industry, make no mistake about that; they are not equal to us in production but are a too-close second.

They excel us in developing weapons of destruction because their universities and their experimental plants worked together and their engineers

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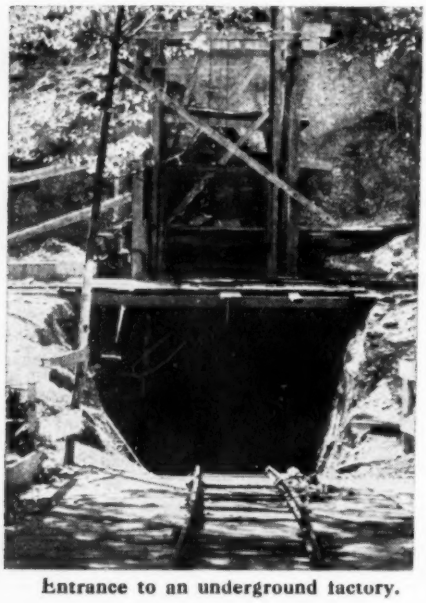
Mr. Weatherhead is president of the Weatherhead Company, Cleveland, Ohio.

and scientists spent all their time, their efforts, and their ingenuity on death-dealing weapons while we here were thinking of peace products and a higher standard of living.

One of the most ingenious factory layouts I have ever seen was an underground aircraft factory located near the town of Mossback, Germany. Its location was the site of a former gypsum mine, the entrance to which is the side of a mountain, hardly discernible until you are almost directly in front of the entrance itself. The various tunnel arteries of this factory were ingeniously laid out and equipped as efficient mass-production lines—complete to specially designed conveyors for carrying the work from one machine to another. This factory had a labor complement of 8,000 slave workers.

I THOUGHT all the way home about the problems of war and about the San Francisco efforts for a lasting peace. My opinion swings to the proverb: "An ounce of prevention is worth a pound of cure." The ounce I recommend is the complete disincorporation of German industries, as well as the intensification of German agricultural efforts toward building a model agricultural nation.

The sting of the first would be alleviated by the prestige that would accompany the latter. Disincorporation and allied administration of German industries would allow the continuation of certain German science and the undeniable benefits derived therefrom, yet eliminate any opportunity for Germany to rearm for war.



Entrance to an underground factory.

Those are just a few of my views about German industry. I can't do anything about its final settlement and probably neither can you. That's the Government's job. But the future of Germany's industry is a dangerous problem for the allied planners who are approaching the crossroads in establishing the peace. I hope they give it all the attention it warrants.

The excellent condition of Germany's land is an enviable asset of that country. The Germans take scrupulous care of every bit of their land and doubtless have the best farming in the world. America, rich in land, would do well to exercise the same attention and care. The surprising factor about German farming is its lack of mechanized farm equipment. The Germans still use what most of our farmers would call primitive manual farming methods. America is years ahead of Germany in this respect.

Compared with other soldiers our own GI Joe is the guy of guys. He takes his work as a soldier seriously, yet good-humoredly. He's resourceful, self-sufficient, hard-working. Most of all, he's always courteous, helpful to others, and concerned for the welfare of his fighting buddies—and he's well-behaved. He's tickled to death the fray in Europe is over. He was ready and willing to pitch in and do his bit to lick the Japs, even though he wistfully talked about getting home, getting a job, playing golf, dating that girl again, and having a home of his own.

GI Joe shows he is a happy fellow, but one who has his feet firmly on the ground. He is doing a lot of level-headed thinking about that postwar job, and he hasn't forgotten the resentment he felt every time he heard reports about the strikes and absenteeism back in the States while he was in the thick of battle before V-E Day.

THE GI of World War II is an intelligent, democratic citizen. It will be a better tomorrow in America when he comes home and puts his earnest energy and sound philosophy into peacetime practice.

Finally, as a result of all I have seen and experienced in Europe—the awful devastation and ruin, Germany's threatening industrial potentiality, the atmosphere of hate, intrigue, and undefeatability—I have come out of Germany with one of the strongest convictions I have ever had in my life: *America does not need compulsory military training but does emphatically need compulsory preparedness for national defense.*

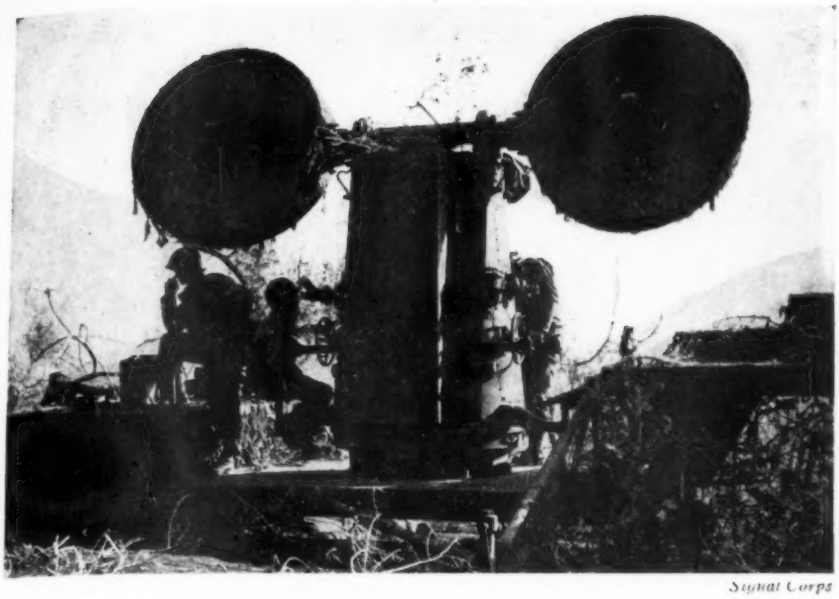
By compulsory preparedness for national defense I mean the constant development of instruments of war and the ceaseless continuation of such marvelous scientific research as that which has produced the new wonder of the world—atomic energy. It is results of research like this that America must continue to develop and create if we are to protect ourselves against aggression.

In two World Wars we have given a highly aggressive and scientifically minded nation a tremendous head start, but both times we managed, just by the skin of our teeth, to catch up and outstrip him. Next time, from whatever quarter trouble may come, we may not be so fortunate. Because the next war, if there is one, may be won or lost in the first few days.

Germany's progress in weapons of destruction very nearly defeated us in this war. Only by tremendous effort and at tremendous cost did we and our allies manage to outproduce her industry and defeat her army. Germany made itself a threat to the world because for nearly ten years that nation and its people put almost one hundred per cent of their efforts into technical preparations for war.

I believe this war teaches us a big lesson. We must compel ourselves to further our Nation's technical and scientific development. This can be done only if, as in Germany, *our* educational institutions, *our* industries, and *our* Government put their heads and efforts together. I propose that America form a preparedness panel composed of these groups. I further propose that a constant program of development of weapons for defense operate under the guidance of this panel.

Very likely some incentive, such as a preparedness foundation award, similar in concept to the Nobel Prize, would have to be founded. Such an award could be offered yearly to the individual or institution making the greatest contribution to the advancement of national preparedness. Only by such combined efforts will America hold and advance its position as the world's First Arsenal of Democracy.



Signal Corps

Radar Revolution

It Has Brought About a New Science of Ground Gunnery and Air Tactics

Dr. Louis N. Ridenour

OUTSTANDING among the new technical weapons which have played such a great part in World War II is radar. For, while the final date of Axis surrender was determined by our use of the atomic bomb in August 1945, August of 1940 saw the *Luftwaffe* attacking England in preparation for a Nazi invasion which the British were so tragically unready to meet, and it was radar which saved the island on that occasion.

Our enemies had radar, too; but right through the war our equipments and techniques were far better. Credit for this achievement must be shared among many. The earliest workers in radar were scientists in our Navy and Army research establishments. By the time of Pearl Harbor we were well prepared with effective service equipment both for ships and for ground use. Dr. Vannevar Bush's Office of Scientific Research and Development, through the National Defense Research Committee, spent more money on new radar developments than on any other single war research item. Most of this work was done at the specially created radiation laboratory set up at the Massachusetts Institute of Technology and staffed by physicists from all over the country. While this work was originally regarded as being long-term, most of it paid off in combat results. The industry of the country geared for radar engineering and production in an entirely unprecedented way, turning out final models of radar equipment sometimes only six months after receiving a crude breadboard from the scientists.

RADAR has two useful basic properties: it can see in the dark or through cloud and smoke, and it can, from a single station, measure target range with an accuracy better than that of the best visual measurement. The first property has revolutionized air tactics; the second has revolutionized gunnery. The synthetic word "radar" is compounded of initial letters from the descriptive phrase "radio detection and ranging."

Radar techniques are much like those of radio communication; but, unlike radio, the radar transmitter and receiver are located at the same place. The transmitter sends out pulses—short, sharp bursts of energy—and the receiver records the echoes of these pulses sent back by objects in the vicinity. These objects may be hills or buildings, ships on the sea, or planes in the air.

In any case, since the radio waves used by radar travel with the speed of light (186,000 miles a second), the time elapsing between the transmission of the pulse and reception of the echo will measure the range from radar set to target. Means have been developed for measuring this time, despite its shortness, with extreme accuracy.

Usually knowledge of the direction of the target is also required. This is obtained by making the transmitting and receiving antenna of the radar (usually a single antenna is used for both purposes) directional, so that the pulses are sent out and the echoes received in a beam, like the beam of a searchlight.

Radar data—range and direction of targets—are reported on a cathode-ray tube called an indicator. The most generally useful form of indicator is the *PPI* (*plan position indicator*). With the radar set as a center, the PPI plots the positions of targets on a true map. Range is shown as distance from the center of the tube; bearing of a target from the set is reproduced by the bearing, from the center of the tube, of the bright spot produced by the echo. Other types of indicator, meant for special purposes such as the highly precise measurement of target range, are in use.

Radar air defense started as a simple concept and developed organization, complexity, and effectiveness undreamed of at the beginning. Radar for *air warning* has as its purpose simply the display of the locations of all aircraft within range of the equipment so that the defenses can be alerted and put on the job. Defending fighters can be guided to the incoming aircraft by instructions from a ground controller at a radar station and can make visual interceptions of the enemy from there on. It was this technique which, despite the poverty and exhaustion of the RAF fighters, saved England in the fall of 1940.

It is necessary, of course, to be able to distinguish hostile from friendly aircraft. Both make the same sort of radar echo, so a special sort of electronic device was provided to reënforce and make characteristic the echo from friendly craft. This is called *IFF (identification of friend and foe)* and is installed on every aircraft and ship of the allies.

The *Luftwaffe's* shift to night bomb-

Dr. Ridenour, head of the radiation laboratory at the Massachusetts Institute of Technology, wrote this article exclusively for ARMY ORDNANCE at the request of the editor.

ing in the winter of 1940-1941 was countered by the RAF through their development of ground-air teamwork by means of which ground radar stations picked up the raiders, coached friendly fighters onto their tails, and then turned the job over to a special radar observer in the night-fighter plane itself. The interception was completed by making use of information from the plane's radar, and frequently the first news the German aircrew had of all this was machine-gun and 20-mm. fire ripping into them from behind. The ground radar stations developed for preliminary control of the nightfighters were called *GCI* (*ground-controlled interception*); the air-borne radar carried by the planes was called *AI* (*aircraft interception*).

Another use of radar early exploited by the British and U. S. was that of sea search and attack. The importance of the submarine to the European war was so great that a major effort was made to seek out and destroy U-boats. Air-borne radar carried by aircraft, called *ASV* (*air to surface vessel*), made it practical to conduct systematic and continuous air search, regardless of night or poor visibility.

The range at which modern ASV equipment can see a surfaced submarine, even on the brightest and clearest of days is greater than the maximum range of visual detection. Radar's waves do not penetrate water, of course, so that radar can only find surfaced submarines, but, despite this fundamental and inherent limitation, the Germans have given radar primary credit for defeating their U-boats.

AT first, air attacks resulting from radar detection of surfaced submarines and enemy surface ships were pressed home visually. However, visibility did not always permit an effective attack. A device which wedded precision radar with the Norden precision bombsight was developed to permit entirely blind bombing attacks on radar targets. Called *LAB* (*low-altitude bombing*) this device has been responsible for the sinking of hundreds of tons of Jap shipping by our Army Air Forces.

ASV radar's ability to show its surroundings is not limited to the display of ships and surfaced submarines, of course. Shorelines, islands, buoys, and the like are faithfully displayed. Such radar equipment is thus highly useful either to a ship or to a plane for navigation by pilotage under conditions of low or zero visibility. Ships can use it for station-keeping in friendly formations at night, as well as for detection and attack of hostile ships and aircraft. *IFF* (*friend or foe identification*) here serves to distinguish friendly and hostile aircraft and ships.

Air navigation by radar in the vicinity of coastlines soon disclosed that it was possible to obtain good enough radar echoes from river banks, hills, and built-up areas to distinguish such important physical and cultural terrain features from open country. Improvements in radar equipment have made this increasingly easier.

Today, radar navigation inland is nearly as simple as it is in coastal areas, and—what was more important to the war—strategic bombing targets could be recognized on the plan position indicator of a suitably modified air-to-surface-vessel set with sufficient precision to permit bombing of such a target entirely by radar, through clouds or smoke.

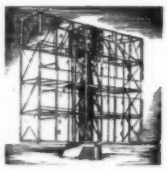
The code name given to U. S. equipment used for such blind bombing is H2X or "Mickey." Twelve airplanes with hand-built equipment of this type led the entire Eighth Air Force between November 3, 1943 (date of the first successful radar raid, on Wilhelmshaven) and April 1944 when production radar of this type was first used in battle. During November 1943 the Eighth broke its former record for total number of raids; during December it first carried a tonnage as big as that of the RAF. Yet in those two months, only four raids were visual; the rest were all guided to the target by the same few preproduction Mickey sets.

Every B-29 was equipped with a similar set, and the weather over Japan is so foul that more than three-quarters of their bombing was done by radar. Many heavy attacks by B-29's, not two atomic bombs, devastated Japan; and the scale and effectiveness of the effort achieved by the Twentieth Air Force would have been impossible without radar.

The revolution in gunnery produced by radar stands out most clearly in two applications: naval gunnery against surface targets and heavy antiaircraft gunnery as practiced by the Army. The performance level of present-day Army antiaircraft artillery is head and shoulders above that of any other service.

At the outset we should state that radar is not the beginning and the end of antiaircraft gunnery. It is an important member of a team which also includes guns, gun-mount drives, special fuzes, and modern directors; but it is an indispensable member of this team.

The Army's radar for antiaircraft artillery is called the SCR-584. Its development commenced at the radiation laboratory at M.I.T. in February 1941,



contracts for production were given to General Electric and Westinghouse in May 1942, and deliveries commenced thirteen months later. In subsequent months, this set fought on every important front in Europe and Asia.

Principal emphasis was put by the set's designers and by the Antiaircraft Artillery Board on accuracy. In order to get the same accuracy in combat as on the firing range, following of a target by the radar was made automatic, so that neither the fear nor the fatigue of operators in combat would mar the tracking. Data transmission to the director and from the director to the guns was likewise made automatic and so was the positioning of the guns. Phenomenal accuracy was achieved by this automatic operation.

The SCR-584 and its teammates defeated the German buzz-bomb. While fighter planes participated in the defense, antiaircraft artillery constituted the primary reliance—in bad weather the only reliance. Radar was always used for initial pickup of a target and for range finding throughout the shoot. When the weather was bad, which was often, it was used for finding angular position as well.

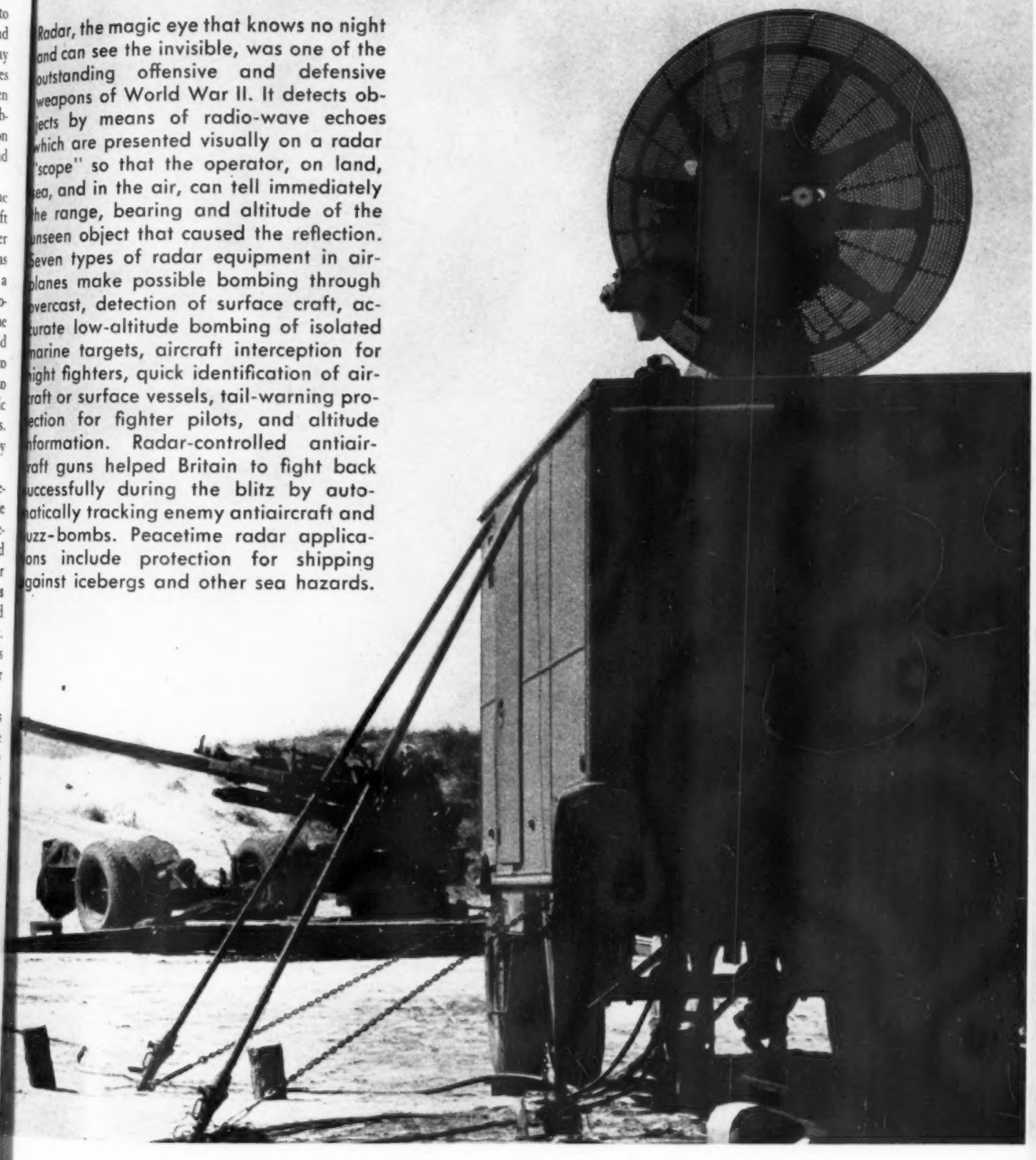
Another use for the SCR-584 was pioneered on the Continent by the U. S. tactical air commands. They reasoned that if radar could find the position of a plane well enough to shoot it down it could be used to track friendly planes and guide them to their targets by radio directions from a controller at the radar.

Radar had many other rôles in the war but there is not space to describe them here. Its development from an idea in the early 1930's through the cumbersome but all-important radar of the war's beginning to the convenient, compact, and versatile instrument of today is one of the greatest success stories of all time.

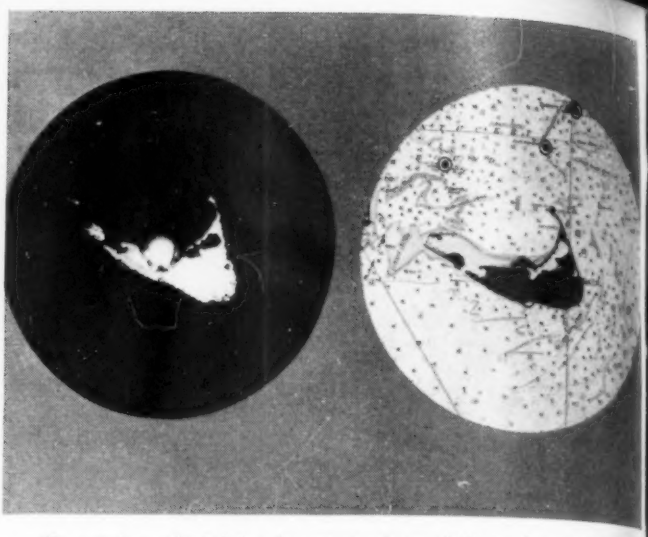
RADAR—

All-seeing eye of war

Radar, the magic eye that knows no night and can see the invisible, was one of the outstanding offensive and defensive weapons of World War II. It detects objects by means of radio-wave echoes which are presented visually on a radar "scope" so that the operator, on land, sea, and in the air, can tell immediately the range, bearing and altitude of the unseen object that caused the reflection. Seven types of radar equipment in airplanes make possible bombing through overcast, detection of surface craft, accurate low-altitude bombing of isolated marine targets, aircraft interception for night fighters, quick identification of aircraft or surface vessels, tail-warning protection for fighter pilots, and altitude information. Radar-controlled antiaircraft guns helped Britain to fight back successfully during the blitz by automatically tracking enemy antiaircraft and buzz-bombs. Peacetime radar applications include protection for shipping against icebergs and other sea hazards.



Radar is one of the most versatile military weapons. Two students, above, at the Army Air Forces School at Boca Raton, Fla., examine the radome which houses the radar antenna on a B-17.



Comparison of aërial radar scope photo of Nantucket (left) with actual chart of island. Land areas appear white, water black on radar screen. Aircraft and ships also appear as white dots.

Radar maintains watch near an antiaircraft emplacement at Mignano, Italy (left). Radar also serves to control searchlights, below, so that the beams will strike enemy planes instantly.

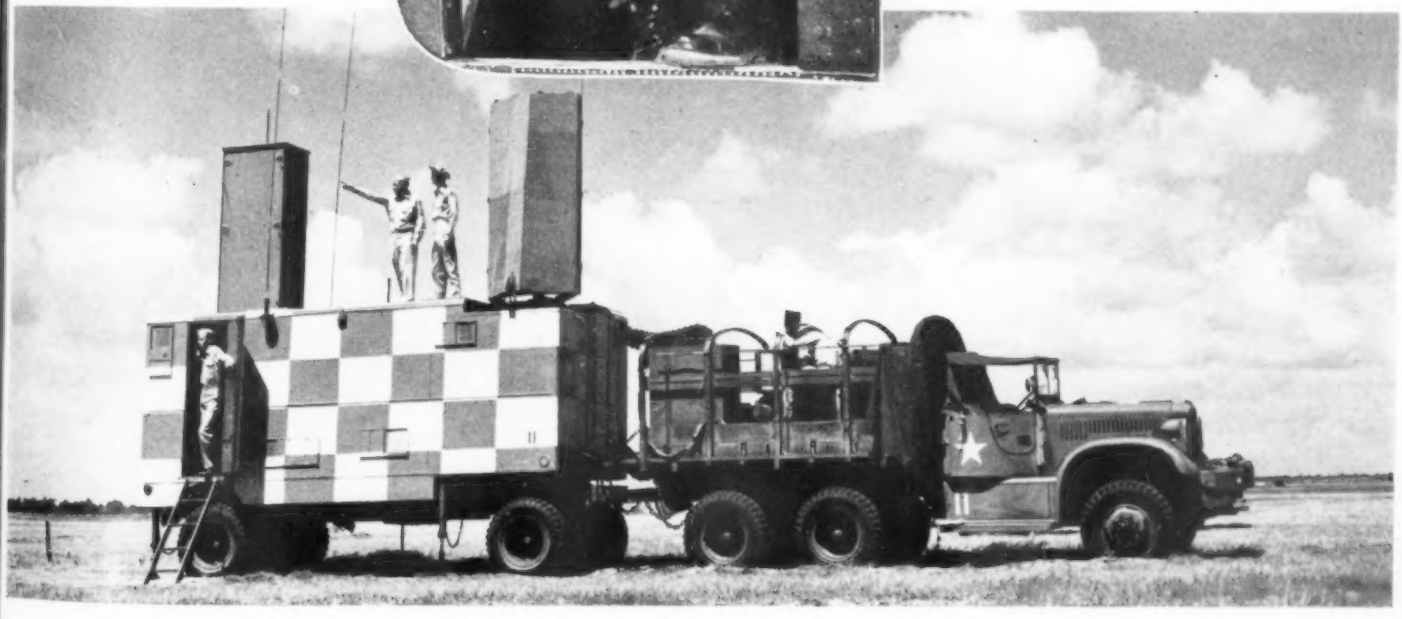
A complicated system of recording and coördinating reports from many scattered radar sets has been evolved by the Signal Corps to provide maximum protection against enemy air attacks.

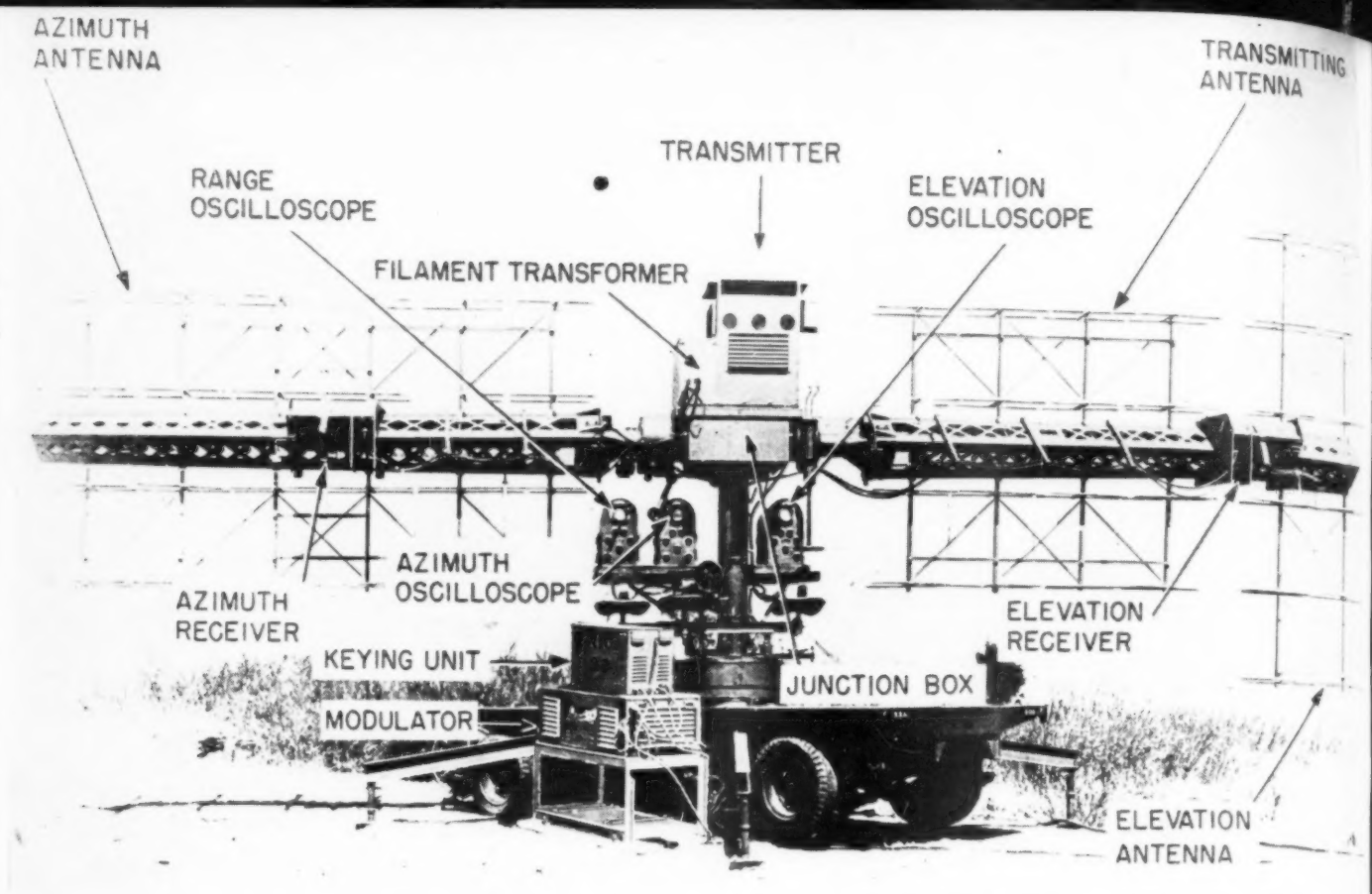
Ground-controlled approach (GCA) Army radar technicians, above, inspect the search antenna used to guide friendly airplane pilots in making landings blind or in strange areas.

A group of Army technicians operate the mobile GCA set above. The final controller talks the pilot into a landing position over the runway. The set maneuvers the plane down to within about 10 feet of the ground.

Paratrooper, right, ready to jump with a radar set, operated by advance air-borne units as a ground beacon for troop-carrier planes that will follow. Set weighs 30 pounds. Later models are lighter and more compact.

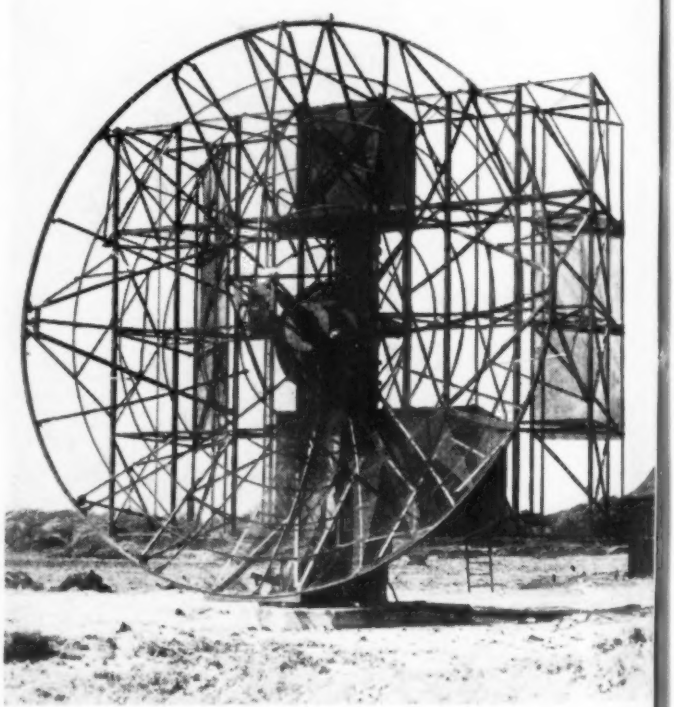
A crew primes a GCA trailer, below, before beginning operation. The trailer is towed by a 6-wheeled truck. The unit, well adapted to swift offensives, is highly praised by pilots.





A broadside view of one of the most successful mobile radar sets, SCR-268, used by our ground forces. Radar control of antiaircraft artillery supplies firing data to a gun director. The electrical impulses from the radar are fed to the director which automatically points the guns and adjusts the fuze setter for the correct altitude. This equipment was particularly effective in aiding antiaircraft guns to shoot down German night bombers over the Anzio beachhead. Radar also made a great record in helping stop enemy buzz-bombs.

Radar set with 5-man crew in operation on an Italian hillside (below). The three operators seated on the mount see indications of the airplane echo on cathode-ray oscilliscopes. One operator tracks aircraft in azimuth (direction in degrees from north), another tracks in elevation, and the third operator measures range.



This British fighter-direction aërial system, above, comprises a ground-controlled interception structure and rotation gear on which is mounted a 33-foot-diameter paraboloid which gives greater discrimination on aircraft track. It is used for offensive operations.

The Ordnance Library

ALL members of the Army Ordnance Association are invited to cooperate in plans for the establishment of The Ordnance Library. The library is to be housed eventually at national headquarters of the Association in Washington and will be an outstanding collection of armament literature in all its phases—technical, scientific, and economic. Here will be gathered in one place for the use of members and accredited students of the subject the best source materials on ordnance and allied military topics.

¶ It will be the aim of The Ordnance Library to secure original documents relating to the prosecution of this war from the standpoint of industrial preparedness. Here will be accumulated under the most modern library conditions narrative accounts not only of the performance of American weapons in battle but also of the achievements of American scientists, engineers, and industry itself in meeting the great armament responsibilities of World War II. Additions to the library and its general operation will be under the control of the Association's Committee on Library, headed by Brig. Gen. R. H. Somers.

¶ In the meantime, members are urged to coöperate in every possible way in this most important Ordnance project. Many members have accumulated libraries of their own which they may like eventually to present or bequeath to the Army Ordnance Association. Other members may have friends whose professional activities are allied to Ordnance operations. The latter may wish to present their volumes to the library where they will be available to students of armament preparedness.

¶ Members are urged to advise the Association whenever they have volumes for presentation to the library. Until adequate quarters are available, such volumes will be stored safely. Each gift to the library will be properly inscribed with the name and residence of the donor. Members are also reminded that the value of a library given to an educational institution may be deducted from the donor's income tax. Libraries which in the normal course might bring only a small fraction of their worth when sold to settle an estate may be of tremendous value to the Association's collection. Further details will be announced from time to time in these pages.

THE ARMY ORDNANCE ASSOCIATION

705 Mills Building Washington 6, D.C.

Signposts of the Future

MORE than most professions the military is forced to depend upon intelligent interpretation of the past for signposts charting the future. Devoid of opportunity, in peace, for self-instruction through actual practice of his profession, the soldier makes maximum use of historical record in assuring the readiness of himself and his command to function efficiently in emergency. The facts derived from historical analysis he applies to conditions of the present and the proximate future, thus developing a synthesis of appropriate method, organization, and doctrine.

¶ But the military student does not seek to learn from history the minutiae of method and technique. In every age these are decisively influenced by the characteristics of weapons currently available and by the means at hand for maneuvering, supplying, and controlling combat forces. But research does bring to light those fundamental principles and their combinations and applications which, in the past, have been productive of success. These principles know no limitation of time.

¶ Consequently, the Army extends its analytical interest to the dust-buried accounts of wars long past as well as to those still reeking with the scent of battle. It is the object of the search that dictates the field for its pursuit. Those callow critics who hold that only in the most recent battles are there to be found truths applicable to our present problems have failed utterly to see this. They apparently cling to a fatuous hope that in historical study is to be found a complete digest of the science of war rather than simply the basic and inviolable laws of the art of war.

¶ Were the accounts of all battles, save only those of Genghis Khan, effaced from the pages of history, and were the facts of his campaigns preserved in descriptive detail, the soldier would still possess a mine of untold wealth from which to extract nuggets of knowledge useful in molding an army for future use.

—Gen. Douglas MacArthur.

Abolish Fortifications?

Modern Tactics Still Indicate Their Intelligent Use

Lowell M. Limpus

The fall of the Maginot, Mannerheim, and Siegfried Lines and the Atlantic and West Walls in World War II would seem to indicate that such fortifications have outlived their usefulness. It was their abuse, however, rather than their use that proved their undoing. When employed as defensive shields for mobile field armies they still have a place in modern warfare.

ORDNANCE people are naturally conservative—which is another way of saying cautious. They have to be. They can't afford to make mistakes. Their price per error is apt to be too dear, and it is frequently paid in human blood. Therefore they demand all the evidence before they come to a conclusion.

And they are entitled to a lot more evidence than they now have with regard to the value of the huge, concrete, gun-studded fortifications that played such a prominent part at the beginning of this war.

Too many eager analysts seem to have "written off" the great defense lines as a total failure, without considering all the evidence. But it behooves us to study it carefully before we reach a final decision concerning them. There may be two sides to the story.

Long-range conclusion jumping, be it repeated, seldom proves profitable in any field, but it is especially dangerous in the military sphere. We've seen too many examples of it. One of the most striking in the recent past was the French conclusion that their Maginot Line rendered France impregnable to attack.

There can be no doubt that many professional military students reached totally wrong conclusions about such fortifications during the interval between the two World Wars. They announced that the possession of these works gave the defenders an advantage which no attacker could overcome, except at a prohibitive price. They built a whole system of defensive strategy and tactics on this belief and sold it to the field commanders. Marshal Gamelin became an exponent of that doctrine, and he was undoubtedly sincere.

He was also undoubtedly wrong. History proved him wrong when the Maginot Line failed to protect France. It certainly did not accomplish its mission. Neither did the Mannerheim Line, the Atlantic Wall, the Siegfried Line, or any of the other well-publicized belts of giant fortifications that dotted the frontiers of Europe. One by one they collapsed as the attackers swept forward.

What, then, does that prove? That such elaborate works are useless? That they have no place in modern warfare? That the great prepared emplacements are as obsolete as bows and arrows?

These appear to be popular conclusions just at present. They are advanced by clever writers and approved by careful editors. They are even shared by some military men, who announce that the war of maneuver has returned and the wheel has turned full circle again.

It must be admitted that, at first glance, these conclusions appear to be justified. But let us remember that so did the conclusions that led us astray last time. And this time it might be well for us to consider carefully just wherein those fortifications failed—and why. The necessary data are beginning to accumulate. Let us consider some of the facts now available and consider them carefully.

IMMEDIATELY we are struck by apparent inconsistencies. The Maginot Line survived the blitzkrieg. No tanks rolled over it or through it. No planes pounded it to powder. The French fortifications were taken only when they were outflanked and assaulted from the rear. And the same thing happened to the Mannerheim Line. It beat off the frontal attacks as it was supposed to do. It fell only when Red soldiers circled around it on the ice and came in from behind. It was outflanked, too.

But things didn't always work out that way. The Atlantic Wall collapsed at the first plunge against it. It simply went to pieces when the allies crashed into it, and they crashed right on through with scarcely more than a momentary pause.

The Siegfried Line was still another story. It wasn't outflanked, and it didn't collapse when rushed. It proved to be a mighty tough obstacle, but it finally gave way under persistent pounding. But it took a lot of pounding.

It begins to appear that the least common denominator in all these problems is no simple factor. It isn't enough to say that the big fortifications proved valueless in this war. It is true that none of them seem to have accomplished their ultimate missions, but they seem to have failed under entirely different circumstances.

A little further study may give us some clue as to why they failed. The explanation for the failure of the Atlantic Wall proves to be apparently simple. It was mostly bluff. Its strength existed largely on paper and in men's minds. It pretended to be what it was not. The Germans advertised it as a great belt of fortifications in depth, but it proved to be no such thing.

Its secrets were unveiled recently by a couple of experts from the Office of the Chief of Engineers. They were recorded by Lieut. Col. Sherwood B. Smith, chief of the fortifications branch of the engineering division of that office, who assisted the chief engineer of the European Theater in a thorough survey of the works made at the request of the commanding general of the Army Ground Forces.

These experts reported that the Atlantic Wall was a hard but empty shell. It was strong in front but it had no

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Signal Corps

General Patton, the Sherman tank, and GI Joe proved more than a match for Germany's strongest fortifications.

backbone. There was nothing much behind the beach defenses. That explains the failure of the Atlantic Wall.

"But what about the others?" the critic may inquire. "They were constructed of something considerably less flimsy than the propaganda of the late Herr Goebbels, weren't they?" They certainly were. They were elaborately planned, carefully constructed, and were formidable defenses in depth. And yet they, too, apparently failed. Why?

Well, it is barely possible that they failed because somebody made a basic error in the fundamental concept which should have governed their use. And that error appears to have been made by some of the world's leading military experts. It seems an almost inexcusable error now, because they deliberately disregarded one of the ancient axioms which have governed warfare since the beginning of recorded history. They tried to revise the fundamentals. They tried to rewrite the military A B C's. They endeavored to improve on the theories laid down by the Old Masters. And then they made the belated but painful discovery that the Old Masters had been right all along. They knew what they were talking about when they laid down their law of fortified objectives.

Back in the bow-and-arrow days, successful commanders discovered that the best way to take a walled town—or any other fortified objective—was first to crush the field forces that protected it. Then it was possible to cut in around it, sever its communications with its supply centers, and besiege it. Given sufficient time, the fortress ultimately would fall of its own weight.

It was this ancient maxim which the French General Staff ignored when it planned to replace the mobile defense of the field armies with a great system of permanent fortifications. It was the maxim which others ignored as well.

They seemingly forgot all that they had ever learned about the proper use of such works. They forgot the corollary which concerns the successful defense of fortifications—that the surest and safest way to hold them is to avoid the defeat of the mobile field forces in front of them.

BUT our erstwhile experts skipped that part of it. They weren't going to rely on any field forces at all. They just overlooked the old lesson—that forgotten lesson which Fletcher Pratt once neatly summarized in ten words: "Fortification does not replace but only aids the mobile defense."

M. Maginot overlooked that salient fact—and thereby led the world astray. It was a rather natural mistake, because the French strategists had the striking lessons of Verdun and Liége fresh in mind. It is evident now that they didn't understand those lessons. They did some high, wide, and handsome conclusion-jumping.

They concluded that the defense of Verdun succeeded while that of Liége failed because of the difference in the construction of the two sets of fortifications. Liége was defended in the old style, by an encircling ring of forts so large that one side of the circle was beyond artillery range of the other. The Germans wrecked it by concentrating the fire of so many heavy howitzers on one fort that they demolished it and so broke into the ring.

That taught the French a lesson, and they were already dismantling the similar rings at Verdun when the Germans hit it with all they had in 1916. The French held Verdun when their field forces fell back into the partially dismantled fortifications and hastily prepared concrete emplacements in some of the tunnels of the old forts. Those concrete pillboxes stood up pretty well, so the French generals outguessed themselves and decided the virtue lay in scattered concrete works and not in the troops that occupied them. They gave the credit to the works instead of the French Army's use of them.

It was a misapprehension that gave birth to the Maginot Line—and a lot of other lines, too, in the end. But the Maginot was the first—and best—of its kind. It wasn't planned as a defensive position for a fighting field army at all.

It was a wall of steel and concrete, with underground homes for the garrison; a great wide belt of forts, so arranged that the fields of fire of their cannon supported and protected each other. It looked awfully strong when it was finished.

IT seemed so strong, in fact, that it misled many military men everywhere, and finally it gave birth to a whole new school of military thought. This school overrated the efficiency of the defense and sold its bill of goods to the public in many countries. It even had its effect upon such men as the clear-thinking Capt. Liddell Hart in England, although his main thesis has been generally misrepresented by a great many people who, it is evident, never took the trouble to read what he actually wrote.

Marshal Gamelin became a convert to this doctrine and so did a lot of lesser lights. The apostles of the impregnable fortification were so confident in those days that they carried a great deal of conviction. It gives this writer practically no pleasure to recall that he was just about as wrong as the rest of them, and he regrets that there is a book still extant in which he solemnly declares that "the construction of the vast defensive zones of modern Europe has rendered a number of textbooks obsolete." Yet one lives and occasionally learns—if he lives long enough.

We've lived long enough to learn quite a lot since then. The Germans illustrated the principal lesson when they rejected the popular doctrine and went right after the permanent garrisons of those impregnable fortifications. The weaker Belgian counterpart of the Maginot Line also went all to pieces after Fort Eben Emael fell.

There have been other lessons since. Hodges smashed a hole right through the Westwall at Aachen and then went on to duplicate the feat in front of Cologne. Patton simply ripped right through the same belt of fortifications at Trier and wasted very little time in doing so. Somehow, none of the "impregnable" defense lines seems quite so impregnable now.

But, if we have learned anything, it should be that we must not leap at conclusions too hastily in this matter. Before we discard the "Lines" as totally useless, let us consider what they actually accomplished.

The Mannerheim Line held off the Russians until the defeated Finnish army, which fell back into it, was literally worn out. The Siegfried Line stood firm against French attacks in the winter of 1939-1940. The Maginot Line did hold out against the Germans for a while—until they broke through Corap's shattered field army and managed to get around behind it.

And that same Maginot Line resisted another smashing attack much more recently, although under less widely publicized circumstances. The fact is that General Patton held it against a furious German assault early this year. He did it after he had weakened his field forces by rushing a considerable portion of them northward to check Von Rundstedt's Christmas drive into the Belgian "Bulge."

That performance of Patton's, incidentally, may provide a key for this entire discussion. "Old Blood and Guts" didn't utilize the French fortifications in the way the builders had intended. He didn't bury his men underground as permanent garrisons of permanent emplacements with the purpose of spending the rest of the war there. He used those fortifications as field works. He wove his mobile ground forces through them in order to hold the position until he was ready to launch a counteroffensive.

General Patton was following approved American tactics—not the French kind—when he did it. That was *mobile* defense; the kind that we've been teaching at Fort Leavenworth and Fort Benning for the last five years. It was evolved by American military planners shortly after the French debacle. It was installed at the Infantry School at Fort Benning that same summer, where the writer first encountered it. Its most earnest advocate was an unknown young officer who had just become commandant of the school. His name was Omar Bradley.

"You must understand what we mean by 'mobile defense,' though," explained the conscientious commandant. "It's the mobility of a recoiling steel spring we're after; a spring which coils back on itself under pressure and flies right back again as soon as the pressure is released. But there must always be a base on which the spring recoils."

Patton used the old French fortifications as that base. They weren't especially fitted for it, because the Germans had dismantled them and turned them about to face in the other direction, not to mention removing most of the guns to ornament the outer crust of that deceptive Atlantic Wall. But it was the best thing available at the moment, and Patton utilized it to full advantage.

His army recoiled into the Maginot Line under pressure, using it as a series of field fortifications for the mobile forces—and when it snapped back it went right through the Siegfried Line which didn't hold at all that time. The explanation appears enlightening. It didn't contain any such mobile field forces just then—only the permanent garrison.

HERE we find the least common denominator of all the lines that failed. They were occupied by permanent garrisons. And permanent garrisons don't appear to be very effective, once the field armies in front of them are beaten. But that isn't exactly a new discovery after all. Julius Cæsar knew that; so did Alexander—and Napoleon.

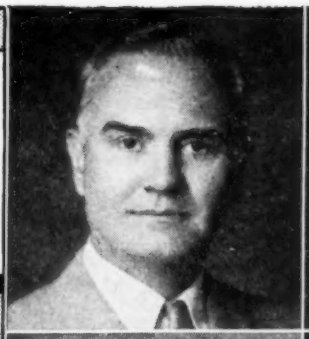
This conclusion brings us back to the feet of the Old Masters once more, and we begin to wonder how they would have applied their ancient doctrine, if they had possessed these modern fortifications. Consideration indicates that they probably would have approved the application taught at Fort Benning.

Thus, today we hold that modern armies, when thrown on the defensive, should occupy the strongest positions available; that they should cling to them as long as possible because of the increased risk involved in retrograde movements in this day of racing planes and speeding tanks. But the new doctrine includes the fortifications among the positions to be thus held.

It doesn't discard them; it merely teaches that they should be used differently; that they should be occupied temporarily by field armies, ready to counterattack at once, instead of by permanent garrisons, grimly clinging to the end. It holds that these armies should utilize the works as field fortifications—and the stronger they are, the better for the army concerned.

Thus the new doctrine emerges as the wisdom of the ancients, brought up to date. In that light, it doesn't discard the great fortifications. It simply insists that hereafter they shall be used more intelligently—and perhaps they will. Anyhow, let's not be too hasty about discarding them.

For Eminent Service We Salute—



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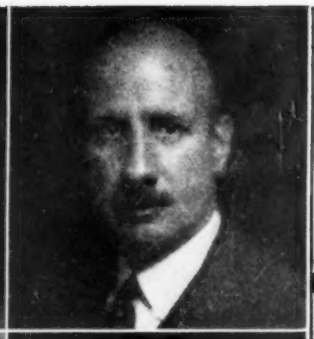

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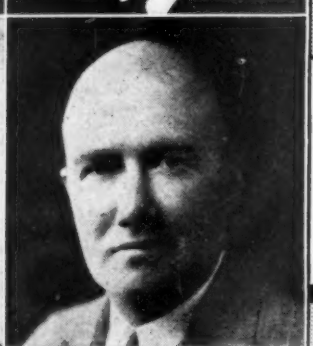

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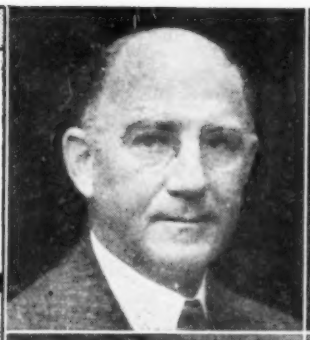
These Industry-Ordnance Leaders



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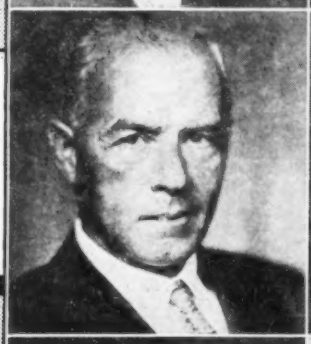
H. P. Richardson, president, The First Boston Corp., Boston, Mass. President, Yankee Post, A.O.A.



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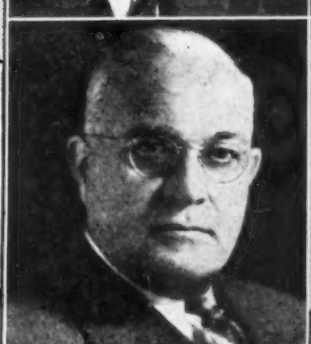
Brig. Gen. R. E. Hardy, chief, Ordnance Ammunition Division. Adviser, Artillery Ammunition Division Committee, A.O.A.

Col. Joseph C. Shouvlin, chief, Cincinnati Ordnance District, Cincinnati, Ohio. Secretary, Cincinnati Post, A.O.A.

John S. Begley, chief, Springfield Ordnance District, Springfield, Mass. Secretary, Hartford-Springfield Post, A.O.A.

Frank B. Bell, chairman, Edgewater Steel Co., Pittsburgh, Pa. Director, Pittsburgh Post, A.O.A.

K. A. Spencer, president, Military Chemical Works, Inc., Kansas City, Mo. Artillery Ammunition Division Committee, A.O.A.



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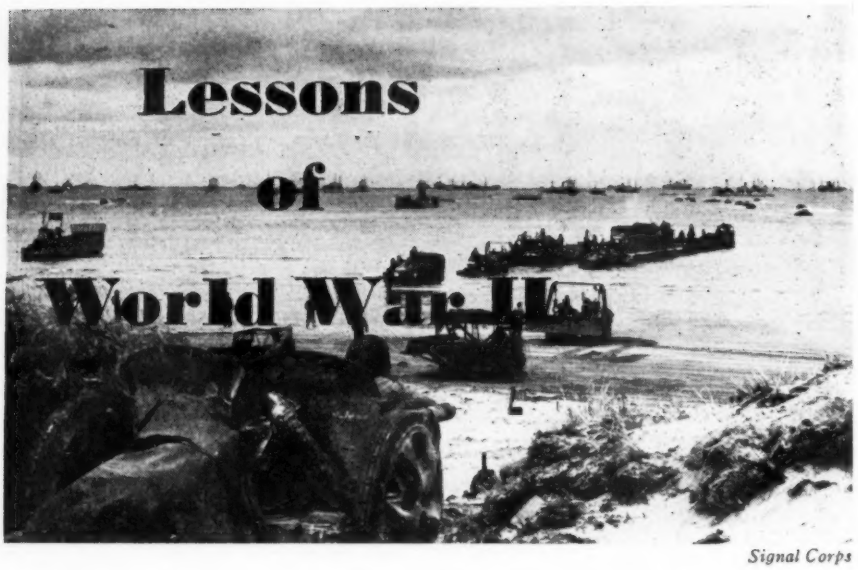

Signal Corps

Coördination—The Cardinal Principle

Mark S. Watson

WHILE General Eisenhower's several campaigns were in progress there were episodes which, at the time, we who witnessed them or their results at close range thought to be of transcendent importance. They sprang from circumstances variously favorable or unfavorable, foreseen or unforeseen, interpreted accurately or inaccurately, and accordingly were things to be remembered with satisfaction, or things to be remembered and guarded against in the future.

In the broader view now available, those episodes cease to tower above the plain. They are recognized as episodes and illustrations, and they will be studied as such in the Army War College and the Army's schools, but as examples rather than principles. Above them in importance are the principles they illustrate.

In listing the grand principles, one must note at the outset the modern employment of air power. This time the airplane was not a novel and promising adjunct to the ground forces, as in World War I, but a major arm of the services whose presence has totally transformed the entire pattern of warfare. We have seen stupendous feats; yet we know that immensely greater feats are about to become possible through the forward leaps of applied physics and chemistry—with what results, no man can predict.

It is true, of course, that the war in the West actually was won by advancing to enemy soil, by pouring in great combat forces and maintaining them by sea-borne supplies, followed by methodical destruction of the enemy's army by our ground forces. But the major task of softening the enemy for conquest and of supporting our sea forces and ground forces alike in their work was that of the air. What lesson can be of much greater importance than this suggests—that the chief instrument of long-range victory, destined to become more potent in years to come, must be a prime concern for the immediate future?

ON the other hand, the air force is an instrument. So are the tank, the artillery battery, the infantry division, the carrier, the cruiser, and the submarine. Each must be developed to serve its own purpose and its indispensable part in the whole combat machine. The balance of all parts is the vital thing in war. With this in mind, one would say that our very first lesson is not to develop efficient instruments, important as they are, but to learn principles. Europe taught us that of them all, the first in importance (and, most fortunately, so recognized at the beginning of American participation and never lost sight of) is the principle of complete coördination of effort.

Pearl Harbor demonstrated how poorly our own Navy, Army Ground Forces, and Army Air Forces had been coördinated up to that time, even when the war was far advanced in Europe and the certainty of our ultimate involvement was recognized by discerning persons. Even then some external pressure was needed to bring Britain's sea, ground, and air forces into systematic unity. It was not wholly a joke to say, as we did in 1943, that Britain's three arms never could have been forced under a single British commander, selected from any of the three. To achieve British unity, if the American Eisenhower had not existed, it would have been necessary for some one to invent an Eisenhower.

For foreseeing this need, and meeting it, too great praise can never be given to Messrs. Roosevelt and Churchill who, as chiefs of state, brought about the Combined Chiefs of Staff setup in Washington and later the Supreme Headquarters headed by General Eisenhower as Allied Commander in Chief with his British deputies. The subordinate American and British staff officers were so scrupulously selected and welded together that at SHAEF there was genuine unity of planning and performance alike.

From that prearranged harmony, which could have come about only by the determination of the chiefs of state and by the selection of a man of General Eisenhower's extraordinary gifts as Supreme Commander, came the allies' successes in the Mediterranean and Western Front campaigns. Only through it could there have been such consistent and almost complete coördination as we saw in the hard days of 1943, the eagerly hopeful days of 1944, the victorious days of 1945. In no other way could air raids have been so timed as to start the easing of our sea and ground operations and local ground attacks so timed as to distract the enemy and make possible large and most effective successes elsewhere.

Coördination was effected, too, and most strikingly, on the industrial fronts. Scientific teams of the several services and of the several nations pooled their efforts and thus multiplied their effectiveness; the development of the atomic bomb, with resultant hastening of Japan's surrender, and with consequences even now incalculable, could not have come to pass without that par-

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ticular form of allied coördination. The landings, if not perfect, made adroit use of our military weapons such as the world never before had seen or believed possible. The German High Command had already shown impressive ability to coördinate its attacks and to unify its attack teams, composed of various nationals. But this was by iron control of subject peoples; such nearly complete unity as Eisenhower achieved was of voluntary allies and was certainly unique in modern times.

COÖRDINATION was the essential principle. It had to be put into practice, not merely in the field operations, but throughout the long and involved steps of planning and preparation. To this end there was built up a vast machine whose ponderous nature made it appear inflexible here and there, but which alone could have produced the men and the weapons capable of overcoming the Nazi fortress in Western Europe.

We now see, better than in the early days, how large was the rôle of industry, and particularly of American industry, in this war, and with what consummate skill our military-industrial leadership, with infrequent lapses and exceptions, conceived, planned, and delivered the stupendous flood of supplies of every character. These enabled Eisenhower's forces to attain victory over Germany at the very time when our industrial machine was also supplying, on a rapidly mounting scale, the first needs of our land and sea and air forces in the Pacific and some very large needs of our allies on other battle fronts.

It is trite to say that the world has seen nothing like it. Moreover, we can remind ourselves that, save for a very few individuals (not including the German and Japanese commands), the world of 1941 did not dream that such a thing was possible.

The wisdom of the allies' chieftains had enabled them to see that this would be a long war and that, as in any long war, victory would come to the side which combined good field leadership with an amassing of stupendous supplies and reënforcements which the field leaders could employ. Short campaigns, historically, have been won by skill in the field; great wars are won by skill plus the endurance which comes from huge economic resources fully employed. Economic superiority eventually gained the victory over Napoleon, over Lee, and over Ludendorff; its victory over Hitler was foreordained.

Yet certainly in 1940-1942 there was room for anxiety about the time which would be required by destiny to bring about this happy result. We need not rack our brains to remember, for instance, that some of our best soldiers were expressing in 1940 a "certainty" of Hitler's crushing Britain and in 1941 a "certainty" of Russia's imminent doom. It is easy to recall the alarms voiced by many Americans about our "folly" in regarding Germany as our first foe and Japan as the second, even when Japan alone was overrunning American possessions.

At home there were also some expressions of anger because even Eisenhower's campaigns were "scattered" and "too weakly pressed" for large and swift success. What could not be publicly recited at the time was the simple fact that our attacks were indeed weaker than desired, but necessarily so because our locally available resources were weaker than desired by us, or suspected by the enemy. Repeatedly our offensives were conducted with fewer troops than the enemy had available in the theater involved and would have used more effectively against us if only he had been sure of our intentions.

What the allied command was engaged in, it ultimately became clear, was holding the enemy in essential defense areas and threatening him in others so as to keep him distracted while we were building up the great forces which alone could achieve the ultimate victory. Necessarily this was our design in the Pacific. Any one could see it, including the enemy. And because our limitations there were unconcealable, the tasks of our sea and air commanders in the whole Pacific area were inevitably made harder. Far fewer observers, even in America, discerned that for a long time our designs in Italy and on the Western Front were dictated by the same kind of necessity, although not to the same degree.

It is well to give this some attention, because only with that in mind can we see how essential it was to get the maximum use of our resources. This maximum could not have been gained except by the coördination spoken of. Coordination, then, was a good thing in itself in those critical days of preparation; it was a better thing later when preparation was followed by performance.

In that later day we had more men and more equipment and a far better position. Even so we had nothing to waste; as far as number of divisions was concerned we had engaged in a constant offensive, not with the attacker's traditional 3-to-1 superiority but with little more than equality—sometimes not even that.

Here, then, the patiently acquired technique of coördination reaped its reward. Save, chiefly, for one dismal affair in the Ardennes (and its ultimate result proved to be far more disastrous to Germany than to ourselves) we were able to maintain an abiding threat

Signal Corps

American trucks dazzled the Germans with their speed and stamina.

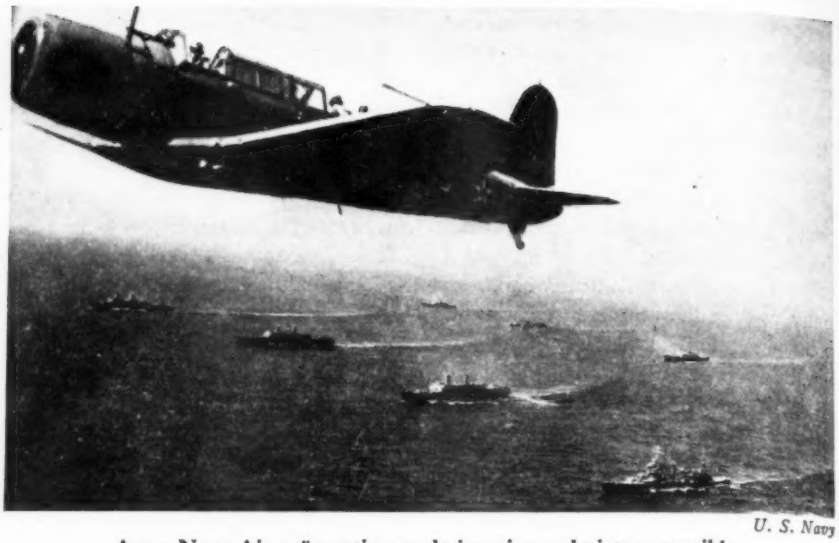
against the foe for almost every mile of Eisenhower's long line from the Alps to the sea and at the same time to strike by well-timed blows in the middle, the north, the middle, the south, again in the middle, and repeatedly in the south, so that the weary foe never had a chance to rest and never to strike, save once, and then with a success so temporary and so costly to himself that he never struck again.

The coördination referred to was so thorough that it included the preparation for the campaigns, the strategic bombing which steadily crippled the foe's industries, the persistent battering of his fighter-plane force which thus freed our troops in Europe of most of the air-borne misery they had encountered in the Mediterranean campaigns, the near paralysis of enemy communications and transport, and finally the skillful moving about of our own troops so that, by admirable timing, they could repeatedly hit the enemy where it hurt him most. Being armed and equipped and ready is part of the fight; placing and timing one's blows to advantage is something else—that is the fruit of coördination.

This has been a large part of military success in any era, of course. But it has been a thing traditionally and notoriously difficult to develop in an alliance, as distinguished from a single military force. There is manifest difficulty in developing it in forces totaling several million men, as distinguished from the few score or hundred thousand whom great captains of history commanded and whose weapons were relatively simple and hence needed nothing resembling today's stupendous supply forces, either for production or distribution.

If coördination be the first lesson of the Western Front, what is its first teaching? That coördination, always necessary to some degree in warfare, is more and more necessary as we increase the number and variety and complexity of our military tools, at the same time raising enormously their power and effective range and greatly reducing the time for using them before the enemy himself can strike.

That teaching is not hard to state or to comprehend. Time will show whether it is hard to accept and to practice. Will a performance as effective as Eisenhower's in welding his ground, air, and sea forces into one superbly effective machine be recognized by America as a performance calling for emulation only in time of war when nothing else will do? Or will it be recognized as applicable in peacetime too?



U. S. Navy

Army-Navy-Air coöperation made invasion and victory possible.

A PLAN for coördinating our defensive means is necessary, but it is mere words on paper unless it is effective and unless the means referred to are so potent as to be worth coördinating. This could be accomplished through the selection, training, and equipping of existing forces, through industrial efficiency, through maintenance of efficient bases of operation, through tireless scientific research, through intelligence, and through sound understanding of other nations.

It could also be accomplished through development of a consistent American diplomatic policy which that understanding should bring about to the extent that we are able and willing to enforce it. This would indicate that the first lesson from the war in the West, or anywhere else, is that the American public has a great deal to learn. Field-command lessons are not the only ones which war can teach, nor military men the only persons who should learn.

The purely military lessons of the Western Front, however, were numerous enough, quite apart from the main one of the virtues of coördination of sea, air, and ground forces. Before they could be coördinated they had to be developed. At no stage is coördination more essential. For this huge task we needed not only a well-founded plan and an alert staff but a great deal of time which happily was once more available to us because our allies were buying it for us.

Time was needed for raising, training, and equipping our forces, selecting our leaders, and building up our supplies and the mechanism of battle. We can hardly miss the import of that lesson—the need hereafter of having ourselves in far better readiness than America ever has achieved at war's outbreak. We may not always have allies who are willing and able to take punishment for a year or more; we may not have sense enough to do our part in creating the war-prevention machinery which hardly needed to be pointed out to us by the San Francisco Conference.

But along with our painful awareness that our lack of readiness frequently caused us to lose positions we later had to regain, equipment we later had to replace, and men we never could restore to life must go a present realization that on the whole we did very well indeed. To this our defeated foes can testify.

Once in action, we had not only a sound plan and excellent leadership and men but equipment which in most respects was far superior to the enemy's. Our air equipment was not only far greater but distinctly better than our foes'. Our trucks possessed such enormous superiority that the German field command was dazzled by the mobility afforded our forces; the enemy commander in the Cotentin Peninsula attributed his early defeat and the loss of Cherbourg primarily to the speed with which Bradley and Collins moved their

strength into the spots where it was needed.

Later we, too, were dazzled by the skill with which our battered but still resourceful foe could move his own reserves into action on occasion, notably in the Ardennes, but this was an extraordinary coup and the more successful by its unusual nature. Our own successes in transport enterprises were consistent.

FOR these points of superiority—and for the stupendous outpouring of all our weapons and types of ammunition—we are indebted primarily to the American industrial machine, great at the beginning of the war and made much greater as the war progressed. American production helped achieve the victory of 1918; it was to a far larger degree responsible for the 1945 triumph. Many will hold that this indeed was the prime lesson of the war. Much can be said to support that view and will be said in a later article dealing with the Pacific war, where the contrast in this respect between ourselves and the enemy can be made more vivid.

History can present nothing comparable to the bulk of American performance in munitions production. There were certain weapons inferior to the enemy's in important respects, but they were few, and to make up for these unfortunate examples there were many American items which were as superior in quality as in quantity.

Our superiority, in brief, was due not alone to the magnificent industrial resources which America possesses but likewise to the military judgment which, far in advance of manufacture, determined what would be the field commander's need, designed the instrument to satisfy that need (often sacrificing certain desirable qualities in order to attain others still more desirable at the moment), and then guided industry toward producing the selected weapon at great speed and in great quantity.

The layman sometimes forgets the time needed for working out a plan long before manufacture begins; hence the vital need of planning with far-seeing wisdom. There is no better example than was cited last spring by General Bradley, one of America's greatest soldiers, as one of Germany's maior contributions to her own defeat. In the years before 1939 Germany was spellbound by air possibilities, as were many in other lands, and particularly by the possibilities of the fighter-bomber as support for advancing infantry.

The Stuka was visioned as a new and swift and powerful form of artillery able to lay down supporting fire on enemy troops who unfailingly would thus be demoralized and then destroyed by the German infantry attack. It thus would perform the function of artillery so well that the Stuka came to be regarded, erroneously, not as a superb addition to normal artillery but as a substitute for it. The Polish and Low Country campaigns seemed to support that thesis.

But in time the British learned an effective defense against the Stuka and soon shot this new substitute for artillery right out of the air. There now was too little German artillery ready to perform its proper and indispensable mission, and, moreover, it now was too late, in Germany's tightly balanced and hence limited production economy, to make the guns needed to cope with the United Nations' 1943-1945 offensives. To that German error we owe much. Because of it our own artillery was vastly more numerous than the foe's. Our gun superiority in the West was a great factor in victory.

Therein lies another lesson of the war—to count on no one instrument, however promising. Germany pinned too much faith in the Stuka aloft, the tanks ashore, the BISMARCK at sea. All were good instruments, but all were beaten down by the variety and number of allied weapons opposed to them.

In quite another field, General Bradley pointed out, the enemy made a grievous error. This was in the faulty battlefield principle of seeking to defend ground for political rather than military reasons and refusing to give up an unimportant position voluntarily, even when it was clear that we would take it anyway. To hold it a little longer the enemy (both in Italy and in the West) would counterattack with insufficient force and thus would lose position, original troops, and new troops as well, and gain nothing.

All through the Normandy campaign, whose success was surmisable from the moment our landing was assured, the stubborn German tendency was to toss in a regiment or a division when the need was for a whole corps, and thus they would lose the troops committed piecemeal, day after day and week after week, and gain nothing thereby. On the other hand a quick retreat to the line of the Seine and another to the Meuse-Vosges line would have permitted two sterling defenses with far less cost to the Germans and far more to the allies.

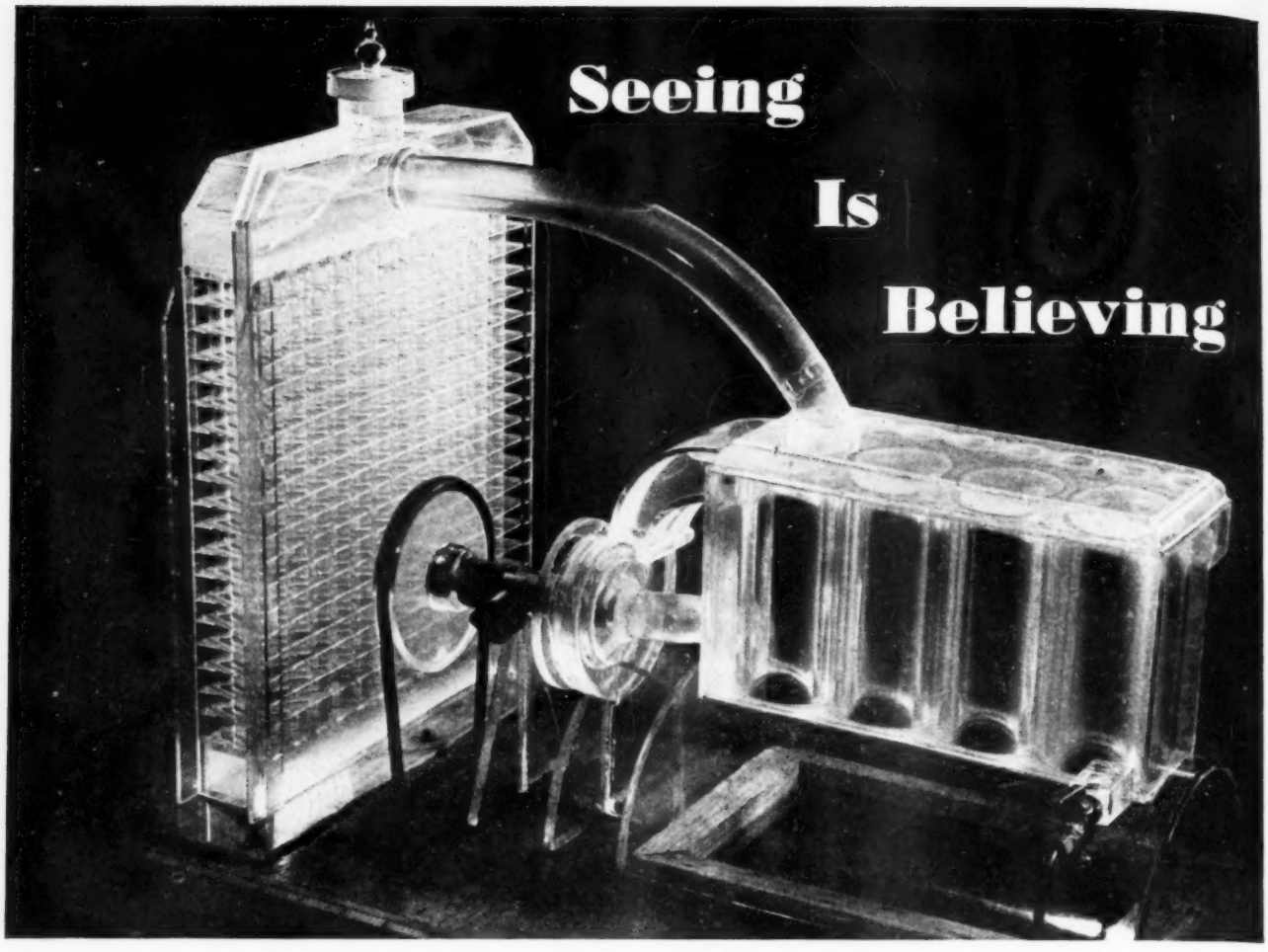
Of this mistaken enemy strategy (which, oddly enough and fortunately enough, our Japanese foes also followed) more will be said in the article on lessons from the Pacific war.

Old-time horse soldiers noted grimly that we and the enemy alike erred in thinking the horse had been wholly replaced by the motor. There were terrains (notably in Sicilian and Italian mountains) where the horse was better for scouting and for supply, and his value was so obvious that animals available on the spot had to be hastily added. One of the most efficient of these improvised units, one might mention, was the "cavalry wing" which the resourceful General Truscott organized from within his own 3rd Infantry Division.

YET, of course, the military planners had been almost wholly sound in limiting their attention to motor-driven equipment, for from grand-scale use of new and powerful mechanical devices came our thundering success. Germany had been close to the fact in that ill-rewarded judgment that the Stuka would be the key to victory. The trouble was that the Stuka was only one part of an air force; the allies were to have all parts, and a multitude of them, and a coördination of them all with each other.

When we strengthened one arm, we did not weaken another; we also strengthened the others in proportion and welded them all into one gigantic instrument, well designed, well built, and well managed. Its size was enormous, its quality unsurpassed, its control unified, its timing calculated, its success inevitable.

Certain phases of our work in Europe were visible on a larger scale in the Pacific, and for that reason will be dealt with in an ensuing article. On the other hand, much that has been said here necessarily applies equally to the Pacific. Certainly it is true of the fundamental point—that the larger and more complex are our forces the greater is the need for years of preparation and training *in advance;* for continuous research and continuous application of new discoveries; for a complete coördination of planning and of operation alike.



Plastic Models Tell the "Inside Story" of Ordnance

Lieut. Earle D. Roberts

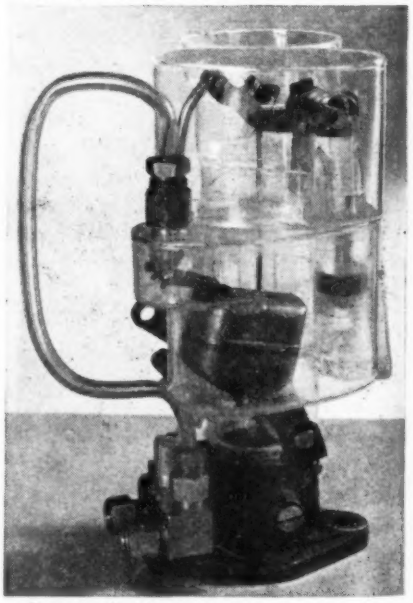
ORDNANCEMEN now learn about weapons "the plastics way," for the latest development in military training allows first-hand observation of what really goes on inside the most intricate pieces of matériel. Transparent plastic models are now being used to provide the proof of exhaustive theory.

The difference their use has made in training at the Ordnance School is particularly notable. Transparent housings for functional parts of machinery and models of weapons made of plastic have cut classroom time fifteen to thirty-five per cent. Potential mechanics and technicians learn better and faster when they can witness the actual mechanical operation as it is being explained by the instructor.

A noticeable rise in student interest and comprehension is attributed to the constant employment of this "see-how-it-works" technique. Instead of attempting to visualize in the mind's eye the working of an automotive engine's cooling system from a maze of lines and arrows on a blackboard, students now witness the actual flow of liquid through a complete working plastic model of the mechanism itself (see illustration above).

The model of the cooling system is the most recent addition to the school's collection of plastic training aids made in its plastics shop. Any mechanism or all of its mechanical parts can be reproduced in plastic with no change in standard size or design. However, if necessary, models can be enlarged and expanded to facilitate instruction on small mechanisms such as lenses and prisms used with fire-control instruments. Some of the models made in the school's shop include carburetor air cleaners, hydrovac brake systems, lens and prism setups, complete caliber .50 machine guns, and 4.5-inch rockets.

Since it is not remarkable that a glass-like material should be transparent, there must be some additional quality about plastic to make it unusual as well



Plastic-sheathed carburetor actually used in a vehicle for over 500 miles.

Lieutenant Roberts is the officer in charge of the plastics shop at the Ordnance School, Aberdeen Proving Ground, Md.

as advantageous. Such a quality is its durability. Plastic can be readily substituted for heavy metals and is equally effective at any thickness from 1/16-inch to two inches.

Plastic housings are made in varying thicknesses depending on the wear and tear to which they will be subjected in demonstration or actual use, for models are not and need not be treated as delicate instruments or locked in a showcase with a threatening "do not touch" sign. A plastic-sheathed carburetor was installed in a vehicle and used successfully for over 500 miles.

PLASTIC also has been a lifesaver in the field. On the Normandy beachhead an unexpected demand for distributor rotors threatened to immobilize many trucks. An Ordnance company improvised the rotors out of plastic salvaged from the nose of a scrapped plane and kept the trucks in operation.

With this conception of the ruggedness of plastic in mind, it is hard to realize that when subjected to a heat of between 220 and 250 degrees Fahrenheit it becomes as pliable as a rubber inner tube. At this consistency its adaptability to molding and bending renders it exceptionally easy to shape into any desired form. Simple, handmade wooden blocks and cylindrical bars are used for shaping tubes and fixtures.

The plastic material (known technically as methyl methacrylate) can be molded by hand, machined, or threaded, and none of the shavings or extra pieces cut off in the process are wasted. Plastic is its own time and money saver. The shavings, dissolved in methylene dichloride, make a cement which holds sections of models together. When the solution dries, there is no trace of it at the points where sections have been joined.

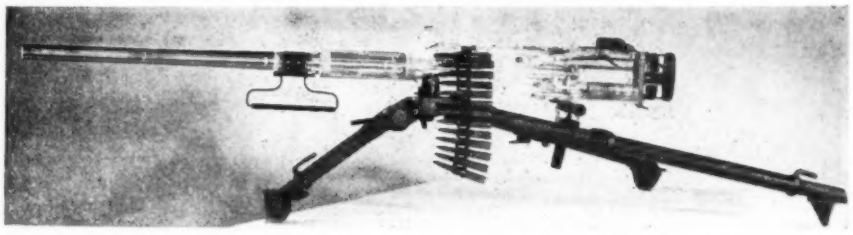
The utilization of plastic at the Ordnance School has already gone beyond the realm of military training aids. The shop at the school put into effect initial plastic technicians' courses outlined by the Surgeon General's Department in connection with the convalescent training program. Occupational therapists from Army general hospitals and soldiers and WAC's from Special Services came to the school to learn the methods of working plastic.

In a 3-week course, members of the classes were taught to handle machine work on lathes, milling machines, and drill presses and became adept at the techniques of fabrication, coloring, forming, and cementing. The instruction stressed quality and accurate workmanship rather than quantity production. Students returned to their stations to teach hospitalized soldiers back from the fighting fronts how to make such useful articles as cigarette boxes, picture frames, notebook covers, letter openers, penholders, and candlesticks.

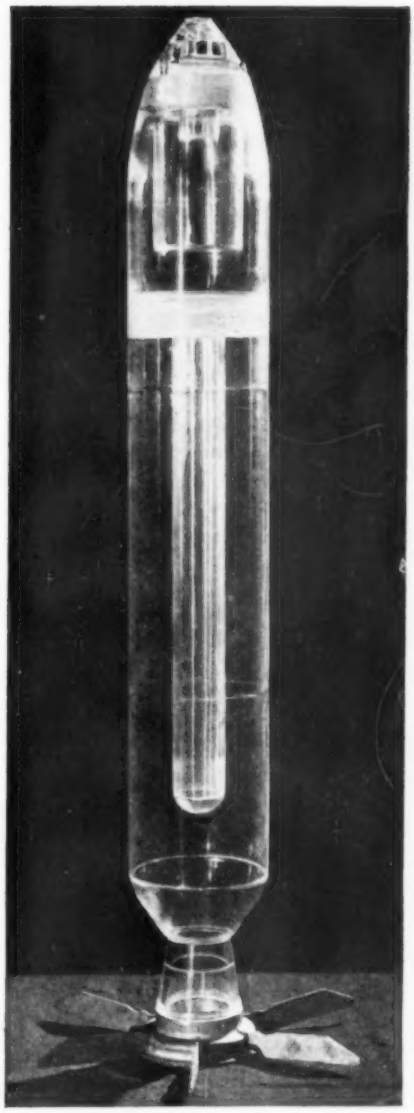
This production serves not only as a pleasant pastime for convalescents but also introduces them to a remunerative field of postwar employment. Once learned, the art can be carried on with relatively small initial cost. Ordinary inexpensive machine and hand tools will equip a small shop as completely as necessary, and all the essential information concerning the procurement of equipment and supplies as well as a list of publications and references are available.

Future possibilities of plastic are limitless, for it can be twisted and shaped into elaborate and yet useful gadgets to beautify household or counter. Light "piped" through tubes enhances already attractive and modernistic fixtures for lamps. Commercial displays will benefit from the extremely decorative qualities of plastic, and letters for marquees and signs can be made three-dimensional.

A few years ago considerably less was known about the values of plastic and the many uses which have since been discovered. The Ordnance School has pioneered in its adaptation to military training aids, and as investigation and experimentation at the school continue new fields of application and future importance are constantly being revealed.



Plastic working model of the caliber .50 machine gun.



All-plastic 4.5-inch rocket model.

EDITOR'S NOTE.—The first of a series of articles on the program and activities of the Ordnance School at Aberdeen Proving Ground, Md., appeared in the May-June 1945 issue of ARMY ORDNANCE, p. 388. The second article, "Training Officer Candidates," was published in the July-August issue, p. 96. A third article of the series, "Training Enlisted Specialists," appeared in the September-October issue, p. 260.

The present article on the use of plastics in making training aids was not originally planned as part of the series. It is published now because of its timeliness and interest to all those concerned with educational training of a technical or scientific nature.

The next article of the series, entitled "Officer Training," will appear in the January-February 1946 issue.

The Nazi Race for Superweapons

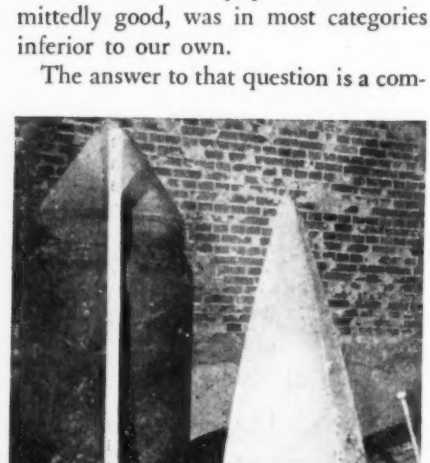
Hillersleben Proving Ground a Model of German Research

Col. W. W. Warner

SINCE the surrender of Germany, Ordnance intelligence teams have been investigating the centers of the *Wehrmacht's* armament research and development. They have found the facilities to be lavishly equipped with research and testing equipment beyond all previous expectation. Their conclusions, after months of detailed analysis, are that German arms manufacture had as its basis a research and testing establishment which dwarfed that of any other country.

The first and most obvious question that comes to mind is, "Why was not German equipment better than it actually proved to be, if it had such a tremendous amount of research behind it?" For German equipment, while admittedly good, was in most categories inferior to our own.

The answer to that question is a complex one, but it can be stated in general terms. It is believed that the main fault lay with the Nazi Party and with Hitler in particular. Hitler wanted superweapons; the idea of a superior weapon of conventional design did not suit him. He wanted weapons such as had never been dreamed of before—weapons which might win the war for him in a matter of days or even hours.



An 84-cm. projectile and windshield.

So while the scientists doubted that such weapons could be developed in time to win this war, they were nevertheless forced to go on with their work in the V-weapon field, devoting much less time to the development of "normal" weapons than was necessary if they were to achieve superiority.

In the second place, the organization of Germany's research and testing was such that it allowed a great deal of duplication, waste, and overemphasis on minor details. In many instances it was a case of the right hand not knowing what the left hand was doing. And worse, both right and left hands would often continue their endeavors far beyond the point of diminishing returns. The profusion of technical equipment could not offset the waste of highly skilled talents inherent in such a situation.

All this was the Germans' loss, but it was very much the allies' gain. When the quality of German weapons is viewed in the light of what it might have been had the Germans taken full advantage of the facilities at their disposal, the inescapable conclusion is that we "got off easy" in the European war.

At Hillersleben, in the Province of Saxony, about eleven miles northwest of Magdeburg and seventy-eight miles west of Berlin, lies one of the main German proving grounds. Despite its size and the abundance of its equipment, Hillersleben was only one of many research and development centers of the Army Weapons Office (*Heereswaffenamt*). It was devoted primarily to artillery and artillery-ammunition development and testing. The other activities carried on there, notably fortification development, flash and sound ranging, and meteorological and communications development, were a very minor part of the program.

There is no exact counterpart in the United States to the plant at Hillersleben. The closest thing to it is the Aberdeen Proving Ground in Maryland, but Aberdeen is concerned with everything that comes under the head of ordnance matériel, from carbines to heavy tanks. Hillersleben was concerned almost solely with artillery and artillery ammunition.

Hitler's desire for fantastic weapons that would win the war at one stroke built up fabulous research and development facilities at the expense of improving normal weapons that might have achieved superiority.

The size of the installations at Hillersleben and the abundance of the equipment there must be seen to be appreciated. A mere description, giving dimensions and enumerating the tremendous assortment of testing equipment to be found there cannot convey the magnitude of the project. But, for the record, here are some of the facts about Germany's artillery proving ground.

It was built in the period 1935-1943, requiring for construction 70,000,000 of the 74,000,000 marks which had been allotted by the German Government. The grounds are roughly pear-shaped, about nineteen miles long and seven miles across at the wide part. The long axis of the proving ground is a 700-meter-wide firing range, which extends approximately north and south from the main industrial area of the grounds to a range of 27,000 meters.

BETWEEN 3,000 and 4,000 people were employed at Hillersleben under the command of a colonel. The camp commandant was a purely administrative official, and here lies a very distinct difference between the German and American organizations for research and development. Nobody at Hillersleben had full technical responsibility for the tests carried out there. This responsibility lay with the Army Weapons Office in Berlin.

There an officer or a civilian would plan a test down to such details as the range safety precautions. These instructions would be forwarded to Hillersleben approximately two weeks in ad-

Colonel Warner is Ordnance Officer of the Ninth Army which distinguished itself in fighting against the Germans on the Western Front.

vance of the test, and at Hillersleben the preparations would be in the hands of proof officers who were under the technical control not of the camp commandant but of the project officer in the Berlin office. The actual test would be supervised and reported on by the project officer.

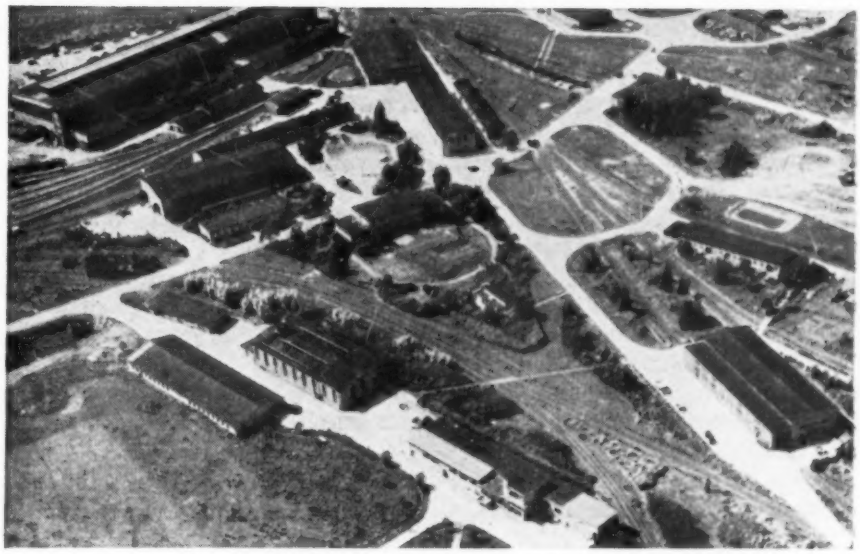
Hillersleben Proving Ground was largely self-sufficient. All facilities, including utilities and housing, were under the immediate control of the commandant. There were guest houses, hospitals, and numerous 2-, 4-, 6-, and 8-family houses for the plant personnel. There was a barrack with a capacity of 500 men. Heat was supplied by a plant within the grounds.

A telephone system connected with almost every part of the camp, and with only a few exceptions all telephone wires were underground—those passing under the ranges being encased in armored cable. Power came from an outside source, but water was supplied from wells within the grounds. The industrial area, range, and test areas of Hillersleben have an extensive network of rail lines which connect with the national railroad system at several nearby towns.

As far as the technical facilities are concerned, with but one or two exceptions they are on a scale that finds no counterpart in the United States. Many mobile measuring units utilized Boulange and camera oscillographs. Photographic facilities were found in almost all the technical buildings. Boulange chronographs, 6-channel Siemens Universal oscillographs, electronic equipment, cameras of all types, machine tools, and stock were abundant. There were at least eight machine shops scattered throughout the plant. Constant-temperature trailers with their machinery were numerous. Power supply was available at outlets of the underground electric cable system near the main firing positions.

Most of the instruments employed in the scientific group were of Zeiss manufacture, and in many cases the acknowledged skill of this manufacturer was found in the most simple instruments.

Photoelectric sky screens were found in large numbers, well made and of rugged appearance. Fuze chronograph equipment was also plentiful. On the main ranges and at the principal outlying proof places were fixed facilities for velocity measurements, all of them housed in permanent buildings and connected to terminal boxes at the test positions by armored underground cables.



The ammunition plant at Hillersleben Proving Ground.

The pickup for the velocity measurement was either by sky screen or by solenoid coil of exceptionally fine construction; a high degree of accuracy (3-mil error) was claimed for the solenoid-Boulange combination. There were four towers for high-angle velocity measurements.

There were also extensive facilities for the preparation of ammunition. The projectile machine shop was capable of performing all machining operations required in the modification of projectiles. One of the unique instruments in the machine-shop building was a gage which in a single operation measured over-all length, diameter, and height above the base at which the diameter is gaged.

A cartridge-case resizing and refinishing plant, an artillery-ammunition assembly building, inert-loading building, a powder-weighing building, a high-explosive melting and loading plant, an ammonium-nitrate building, a building for steaming out high explosive from shells, many ammunition storage buildings, magazines, and igloos, a constant-temperature magazine, and a fuze and primer laboratory—all gave the ammunition section of Hillersleben more the appearance of an arsenal than a testing ground.

It was in the section of the grounds devoted to guns and carriages that the investigators discovered equipment that will probably be of most value to the improvement of American testing methods. In this field the Germans had developed several new and unique approaches to old test problems.

The pneumatic recuperator testing machine is of interest in this regard. It is an air-operated machine which, by withdrawing the piston rod, reproduces actual firing conditions. Of course it is first necessary to know the gun recoil-time diagram, as obtained from actual firings. Then, by regulating the machine, a diagram similar to that on firing can be obtained. For extreme-temperature testing, a liquid of the desired temperature is circulated around the recuperator cylinder within an insulated jacket. The recuperator temperature is automatically recorded.

ANOTHER such machine is the dynamic testing stand which subjected the entire weapon (except the tube) to the forces encountered in actual firing. It consists of a shortened, modified gun into which is inserted a piston, the end of which is bell-shaped. The tube of the unit under test is aligned and placed within the bell of the piston. The device, using a blank round loaded with only eight grams of powder, transmits the forces to the tube and compels it to recoil. The variable factors are the type and quantity of powder, the size of the powder chamber (or the surface of the piston), and the piston stroke.

One of the most outstanding gun-carriage tests ever encountered is the *Treidelbahn*. It is a 3-kilometer road-testing loop, the exceptional feature of which is the towing installation which consists of an electric locomotive equipped with an outboard towing bar.

Several cars can be hitched to the engine, permitting gun carriages to be towed in tandem but with independent drawbars. The locomotive provides an excellent platform for high-speed motion pictures. It is interesting to note that on a test course of 500 kilometers, though the Treidelbahn was reported to be from 5 to 8 times more severe than normal roads it was stated to be typical of road conditions in Russia.

In the measuring house of the Treidelbahn is installed a stationary dynamometer. The drums can be adjusted according to the wheel base of the vehicle. In addition, thin lengths of wood can be bolted onto the drums to simulate a cobblestone road; the drums can also be lowered and raised at various intervals. A combination of these facilities allows torsion effects to occur within the vehicle comparable to those on the Treidelbahn. A traction dynamometer tests the braking qualities of the vehicle.

In all there are ten ranges at Hillersleben. There is the main front (*Schussbahn*), a firing range about 16 miles long and 700 meters wide. A railway runs its entire length along the left side serviced by two gantry cranes, each of 100-ton capacity. In addition there is a 2-track railway behind the firing point with an unloading platform serviced by a gantry crane of 150-ton capacity. Spaced at irregular intervals along the concrete road which borders the left side of the range are thirty-one bombproof observation points.

Fragmentation screen for 84-cm. butts at "H" Platz.

The nine other ranges or "places" (*Platz* in German) are devoted to specific test functions. "A" Platz was primarily an installation of the *Waffenamt Pruf Festung,* and here is a full-scale pilot model of a section of the West-wall. The installation remains intact except for the absence of the turret guns. Air blowers and purifiers, water pumps, telephone cables, power lines, elevators, and complete fire-control equipment are all undamaged. "A" Platz is reported to have served as a training ground for special troops and as an experimental model of the Siegfried Line as well as the setting for the widely known film, "Der Westwall."

"B" Platz was for the testing of concrete and armor-piercing projectiles, all types of armor turrets, armor samples, and concrete. The firing front and butts are serviced by a 150-ton gantry crane. Three huge concrete slabs at the left side of the range and fourteen smaller slabs were apparently built for, and subjected to, test fire by railroad artillery. The firing point is at approximately sixty yards' range.

"C" Platz was devoted to concrete fortifications; it contains a wide assortment of concrete slabs and walls as well as granite slabs which had been fired on by artillery.

The construction and testing of tank obstacles was the purpose of "D" Platz. The obstacles are walls, pyramids, and cones of concrete. "E" Platz had to do solely with tests of shaped-charge projectiles. The butt area contained eight plate frames to support target frames at varying angles of obliquity. "F" Platz was apparently used to determine the effects of mines on vehicles, and possibly also for mine-field clearance experiments. The drawings and plan layouts of "G" Platz were found, but for reasons unknown construction work was not undertaken.

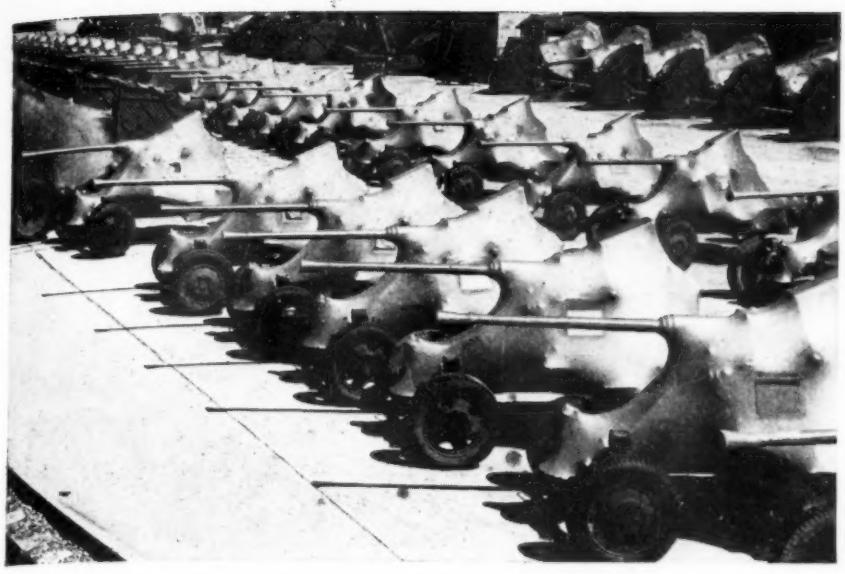
"H" Platz is perhaps the most spectacular feature of Hillersleben. It is a range approximately 1,000 yards wide and 1,400 yards long, and its primary purpose was the test of the 84-cm. gun. The gun itself was removed by the Germans, and all that remains is the mount; but from the size of the butts alone it is easy to see that this was no ordinary weapon. The actual impact area of a single butt is fifteen feet square and thirty feet deep. Before striking the butt the projectile passed through an irregular concrete gallery about fifty by fifty feet and twenty-five feet high.

"I" Platz, which was used for the construction and test of pilot fortifications, has as its outstanding feature a gantry firing superstructure which permits firing vertically downward into the roofs of the fortifications at point-blank range.

ALL this is merely a very brief outline of the main range and the nine "Platzes." Almost all of them contained an abundance of equipment, such as power and telephone facilities, bombproof instrument buildings, darkrooms, velocity-measurement instruments, a railway turntable at the main range, a blast-measuring gauge at "C" Platz, electric jacks for raising and lowering turrets, pressure gauges, ammunition storage rooms, Diesel generators, a tank-towing winch at "F" Platz, and numerous observation periscopes of excellent workmanship in a bombproof building at "H" Platz.

But Hillersleben is only part of the German ordnance picture. Another part is the *Luftwaffe's* Hermann Goering Institute for Ballistic Research, which is devoted about eighty per cent to aircraft research and twenty per cent to ordnance. Here once again the first thing that impresses the visitor is the profusion and adequacy of the physical installations.

The capture in 1943 of an American Norden bombsight enabled the institute to correct certain faults in the German horizontal bombsight. Three-axis antiaircraft fire control was under development at the time of the institute's capture. Probability tables for the destruction of targets, bomb fuzes, antiaircraft missiles, and a large amount of work on rockets were some of the other projects in progress at the institute. Almost all the records of the work done there have been taken intact, and there is no doubt that American Ordnance can gain much from their study.



Wrap 'Em Up!

The Economical Storage of Ordnance

Maj. Max F. Mueller

WITH the war now brought to a successful conclusion and plans for reconversion to peacetime activities in the ascendant, there should be a sober-minded and farsighted consideration aimed at the prevention of future wars and the keeping of our country in a state of constant preparedness against any future aggressor.

All right-thinking men earnestly hope that it will never again be necessary to use in another war the tremendous quantities of Ordnance matériel we have built at such tremendous cost. However, all prudent men will realize that due to the imperfections of human nature this country must be prepared for any emergency, and that when some future M-day comes time will be of the essence.

This problem has long been realized by Lieut. Gen. Levin H. Campbell, Jr., Chief of Ordnance. Early this spring he was returning by air from a visit to Chicago with members of his staff. The conversation turned to the preservation of Ordnance equipment. The general had been considering this matter for some time and recalled certain experiments he had conducted nearly twenty-five years ago at Rock Island Arsenal, Ill. These experiments consisted of placing the steel parts of recoil mechanisms in oil—in other words, canning them. Many years later the steel parts were removed in excellent condition. Here was the germ of what is now known as the "canning" process.

The reasons for devising a new method of storage are sound. The American people have a tremendous investment in the Ordnance equipment which we now have on hand—an investment that must be protected. Due to the great advancement in long-range weapons, it is quite possible that this country may be forced into war overnight, not by a Pearl Harbor attack thousands of miles away, but by an attack launched directly at the homeland. It is obvious, therefore, that the conventional methods of storing weapons—for example, disassembly and coating with cosmoline—could not be tolerated. There just wouldn't be enough time available to clean and assemble the equipment.

Another prevalent method of storage was considered and subsequently discarded. Common experience looks upon ordinary warehousing as a satisfactory form of storage. The experience of the Ordnance Department definitely proves that in many cases inside warehousing permits corrosion as serious as that encountered during outdoor storage. Furthermore, the incredibly enormous amount of equipment produced for the present war has increased the requirement for storage space to the extent that, if warehouses were to be used, the space now available to Ordnance would have to be increased many, many times.

Dehumidified warehouses have been suggested as a method of eliminating the maintenance burden. The use of dehumidified warehouses, except for very specialized applications, would concentrate vital matériel at a few points, which is strategically bad. Only specially constructed warehouses can be dehumidified, and these would be extremely expensive to build. Furthermore, although the items would be protected while stored, expensive packaging would be required for all shipments.

AN analysis of the problem establishes the following fundamental principles:

1. The ideal package will require no maintenance. However, a compromise must be established between the ideal and the practical. Therefore, maintenance requirements should be held to an absolute minimum consistent with practicability. For example, steel containers will require painting periodically, but this requirement should not eliminate the study of the use of steel.

2. The equipment must be tactically redeployable without repackaging. This means that the packs can be shipped to any threatened point and so dispersed as to provide a nonprofitable target from the air.

3. Packaging should require a minimum of disassembly. All items should be stored without disassembling so that equipment can be put into use a short time after removal from the package. This will apply to a certain percentage of the equipment. The greater percentage may be in a knockdown or disassembled condition.

4. The packages must be economical, practical from an engineering standpoint, and reproducible in quantity.

Spray coating, metal barriers, and hermetically sealed containers ensure long life and low maintenance costs for America's war weapons.

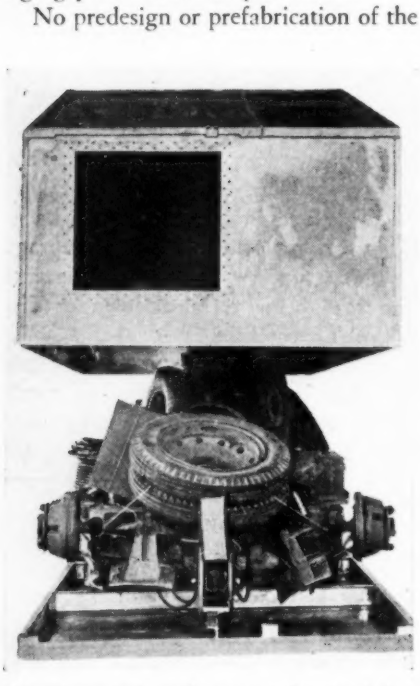
Major Mueller is stationed at Frankford Arsenal, Philadelphia, Pa., and is the research coördinator for the artillery long-term storage program for Brig. Gen. G. M. Wells, chief of Artillery Division, Ordnance Industrial Service.

5. First-echelon parts, tools, and accessories should be included with the package so that the item may be issued directly to troops as a complete major combination. This, of course, does not apply to the disassembled items.

The Artillery Division, Ordnance Industrial Service, under Brig. Gen. G. M. Wells, has been working on the long-term storage of antiaircraft artillery for many months. The 90-mm. gun on M1A1 mount, has been used as a "guinea pig" for experiments in packaging, due both to its complexity and its availability. Under General Wells' direction, Erie Proving Ground and Frankford Arsenal have been studying the use of a spray-formed plastic coating as a means of applying protection to completely assembled artillery weapons. The actual formulation used at present was developed by the Naval Ordnance Laboratory, Silver Spring, Md., and is known as OS 3602.

In this packaging process there is an initial spraying operation, known as webbing, whereby openings and voids of relatively large size are completely bridged over, thus enabling complete envelopment of the item being packaged. The sprayed coating finally produced serves effectively as a durable moisture barrier which withstands exposure to the elements. The bridging feature of the process and the fact that the entire protective coating is applied by spray application make this packaging process extremely versatile.

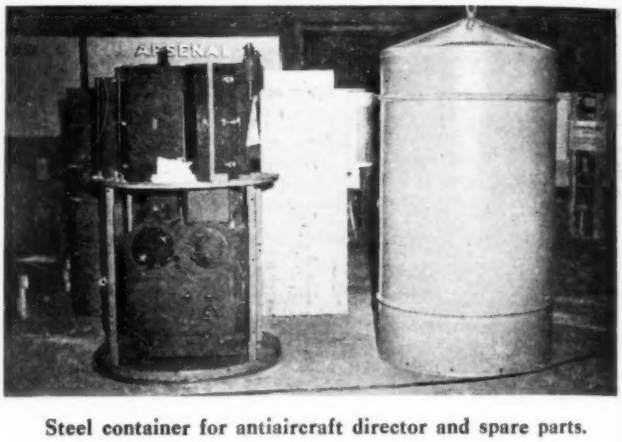
No predesign or prefabrication of the package is necessary. It can be readily repaired, patched, or have additional coatings applied as desired. Furthermore, the packs being sprayed by the Ordnance Department may be top-coated with a sprayable asphalt material to provide additional protection.



Aluminum balanced pressure barrier being lowered over a 40-mm. gun and carriage.

THE great advantage of this type of package is that it can be used to maintain newly manufactured or reconditioned equipment in a serviceable condition pending shipment overseas or pending final packaging operations. This plastic film is now being used as a means of preserving artillery weapons for stand-by storage. The illustration at top of page 423 shows rows of 90- and 40-mm. guns covered and awaiting disposition.

A second method of procedure indicated an improvement on the plastic film, whose main disadvantage was its high moisture-vapor transmission rate. The use of a metal barrier, which has no measurable rate of moisture-vapor transmission, immediately suggested itself. A metal which is easy to fabricate and weld and which combines minimum weight with strength, ruggedness, and long life is aluminum.



Steel container for antiaircraft director and spare parts.

The feature of permitting the wheels to extend outside the barrier, thus providing mobility for the pack, was obtained by fitting the wheel well of the barrier on the wheel studs and preventing a rotating motion by blocking the bogie mechanism. The 40-mm. gun is small enough to be completely encased, and the illustration on the left shows the barrier being lowered over the base plate loaded with this weapon.

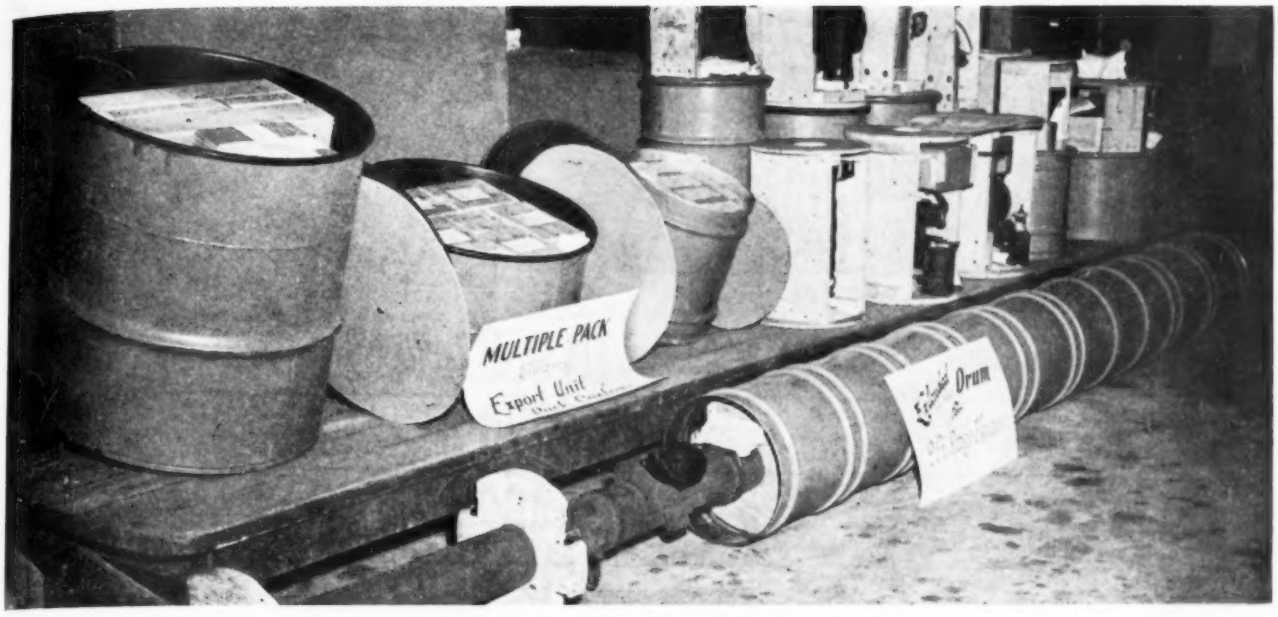
The feature of the design is its "breather" which operates as follows: The air in any enclosure has a varying density when subjected to ambient temperature and pressure conditions such as are encountered in the storage of packages exposed to the elements. In the case of hermetically sealed enclosures, the varying density will cause a variable pressure inside independent of the atmospheric pressure but proportional to the absolute temperature.

If the enclosure is vented, however, a flow of air into and out of the enclosure will occur due to increments of pressure differential between the enclosed space and the atmosphere. This flow is termed "breathing," and its magnitude and rate depend on the range and rate of atmospheric pressure and temperature change.

Since it is desired to maintain the air within the package at a low relative humidity, some device must be employed to dry the air which enters. Such a device is the "Davison Solar Radiation Silica Gel Breather" which has been designed to dry the air breathed into an enclosure under any conceivable natural storage condition. To dry the air breathed in, the desiccant silica gel is employed. The action of silica gel in adsorbing moisture is purely physical, and there is no change in the size and shape of its particles as it becomes saturated. No corrosive or injurious compounds are given off, and even when saturated the particles of silica gel feel and appear perfectly dry. After use, silica gel containing water may be regenerated by subjecting it to an elevated temperature, which operation is known as "activation."

Solar radiation is utilized for this activation. The exposed surfaces of the breather are finished in a dull black. This type of surface has high thermal absorptivity, and thus the solar radiation incident on the surfaces will produce a relatively high surface temperature. The silica-gel bed normal to the solar rays is only one inch thick, and since aluminum, of which the breather is constructed, has high thermal conductivity, the silica gel itself will be heated rapidly.

At the same time the air within the enclosure is heated which causes it to expand, and a flow of dry air out



Extended or shortened drums made from standard containers to pack odd-shaped instruments.

through the breather results. The water in the silica gel is driven from the capillaries and is picked up and swept out of the breather by the flow of warm, dry air from the enclosure, thus activating the silica gel and preparing it for the next breathing operation.

THE third method under consideration goes even further toward protecting the weapon. This method consists of constructing hermetically sealed steel "cans." A desiccant is used to remove the last traces of moisture absorbed on the surfaces inside the container, and the air is replaced with a neutral atmosphere, such as dry nitrogen gas. The frontispiece of this issue shows a large steel can being lowered over a partially disassembled 90-mm. gun and mount attached to a steel skid which is then welded to the top portion. For field-artillery "cans," a method has been devised whereby the recoil mechanism can be exercised from the outside without breaking the seal.

This method has also been applied to all kinds of Ordnance equipment, such as instruments, small arms, mortars, and tanks. In some cases standard drums, which greatly simplify the problem of design and procurement, are used. Extended or shortened drums, as shown in the accompanying illustration, can be used as well as specially designed containers, such as the one for a director.

Proving that size is no limitation, plans are being made at the Office, Chief of Ordnance—Detroit to "can" a heavy tank. The feature of this pack is a pressure-controlling bellows, which is essentially a cartridge containing the same gas as is used in the container and designed to maintain a fixed pressure.

Actually a neutral atmosphere is not entirely necessary. The work of many scientists has proved that dry, clean air will prevent the corrosion of metals and the deterioration of fabrics and organic materials. A consensus of numerous scientific workers in corrosion indicates that safety is assured if the relative humidity is kept under thirty per cent. By the use of clean air of such humidity many design and production difficulties are removed since it is extremely difficult to obtain an hermetic seal on a large metal container, with subsequent leakage of the nitrogen.

The costs involved in "canning" are a vital consideration. Study of the problem has proved that canning is actually the cheapest way of preserving Ordnance equipment for long periods, such as twenty-five to fifty years. Figures now available indicate that the maximum cost of canning to preserve the matériel for this period will be about five per cent of the matériel's value.

It should be realized that huge sums are invested in Ordnance items. A 90-mm. gun on carriage M1A1 costs about $40,000, and a 40-mm. gun with director costs about $17,000. If the traditional method of storage were used with a cost of $1,000 to $5,000 per overhaul, these weapons would cost more in overhaul than their value in 25 years. By canning, it is actually possible to preserve a newly overhauled gun for fifty years for less than the cost of one overhaul.

ACKNOWLEDGMENT is made to the following organizations and concerns which have materially aided the program: American Bridge Company, Ambridge, Pa., for the design and construction of steel cans for artillery; Davison Chemical Corporation and Glenn L. Martin Company, Baltimore, Md., for the design and fabrication of the aluminum balanced-pressure barriers for artillery, aluminum cans for helmets, and containers for small arms; Cargocaire Engineering Corporation, New York, N. Y., for design of dynamic dehumidification units and engineering advice on dehumidification; International Harvester Company, Chicago, Ill., for work on the canning of small arms in oil; Frankford Arsenal for design and construction of cans for instruments, fire-control equipment, mortars, and aircraft cannon; Rock Island Arsenal, for the design of packs for artillery; Erie Proving Ground, Ohio, Frankford Arsenal, Johns Hopkins University of Baltimore, Forest Products Laboratory of Madison, Wis., and the Naval Ordnance Laboratory of Silver Spring, Md., for work on spray-formed plastic films; and to many industrial and research laboratories for consultations, advice, and constructive criticism.

Industry-Ordnance Record of

AMMUNITION PRODUCTION

JANUARY 1, 1940, TO AUGUST 1, 1945

Artillery ammunition	10,958,454 tons
Mortar ammunition	476,312 tons
Grenades and pyrotechnics • Mines and explosive charges	462,029 tons
Bombs and rockets	5,989,603 tons
Caliber .30, .45, and .50 ammunition	38,866,000,000 rounds

SMALL ARMS PRODUCTION COMPLETE ITEMS

JULY 1, 1940, TO JULY 1, 1945

Rifles and carbines • Pistols and revolvers • Browning automatic rifles	15,668,869
Bazookas	476,628
Submachine guns • Caliber .30 and .50 machine guns and mounts	5,293,981
Bayonets • Bayonet knives • Trench knives	9,200,107
Grenade launchers	1,588,140
Helmets	22,619,189
Pieces of body armor	965,702
Metallic belt links, caliber .30 and .50	12,744,000,000

Production in World War II

ARTILLERY PRODUCTION

COMPLETE ITEMS WITH RELATED FIRE CONTROL

JANUARY 1, 1940, TO AUGUST 1, 1945

Aircraft artillery: 20-mm. through 105-mm. — 182,017

Antiaircraft artillery: 37-mm. through 120-mm. — 44,651

Tank, antitank, and self-propelled artillery: 37-mm. through 240-mm. — 183,110

Infantry weapons: mortars, guns, howitzers, recoilless rifles — 112,902

Field and seacoast artillery: 75-mm. through 16-in. — 17,537

Rocket launchers: all types except bazookas — 215,163

TANK-AUTOMOTIVE PRODUCTION

COMPLETE ITEMS

JULY 1, 1940, TO AUGUST 1, 1945

Tanks • Self-propelled weapons • Miscellaneous combat vehicles — 271,165

Light and medium trucks • Light-heavy trucks • Heavy trucks — 2,358,655

Other vehicles — 1,130,406

Remanufacture and modification — 27,914

Ammunition production (except small arms)	$ 9,766,166,000
Small-arms production (including ammunition)	3,600,000,000
Artillery production	5,167,000,000
Tank-automotive production	19,599,000,000
TOTAL	$38,132,166,000

ORDNANCE ROLL OF HONOR

THE following men have been awarded the Distinguished Service Medal:

BRIG. GEN. JONATHAN L. HOLMAN, Washington, D. C.—For ordnance supply, staff organization, and logistical planning for combat operations in the Southwest Pacific Area from March 1942 to October 1944 and during the early months of 1945. In planning for the Philippine invasion he raised the standards of logistical support to the highest level of efficiency, instituting the practice of using ships with specialized loads for task forces. His outstanding ability, sound judgment, and high professional attainments made a significant contribution to the success of our operations in the Southwest Pacific Area.

General Holman

Colonel Dickson

COL. JOHN R. V. DICKSON, El Cajon, Calif.—Serving in the Southwest Pacific Area in the highly important position of Ordnance Officer, Fifth Air Force, from January 1943 to September 1944, he was responsible for providing ordnance matériel capable of inflicting maximum damage on enemy installations. Bombs and munitions then in use had not been sufficiently combat-tested, and satisfactory bombs and fuzes did not exist for all types of targets. Realizing the need for intensive readjustment and development, he accomplished a major reorganization of several thousand Ordnance personnel without interruption of service to combat aircraft.

MR. HOWARD BRUCE, Baltimore, Md.—For duties of great responsibility from July 1942 to June 1945. His leadership in conceiving and bringing to peak efficiency the supply control system greatly improved Army procurement methods. His early endeavor to create an orderly program to conserve critical materials helped alleviate supply shortages. His effort in removing obstacles to production resulted in immediate and lasting improvement in the Army procurement program.

General Boatwright

Colonel Breakefield

THE following Ordnance officers have been awarded the Legion of Merit:

BRIG. GEN. W. P. BOATWRIGHT, Detroit, Mich.—For exceptionally meritorious conduct in the performance of outstanding services as commanding officer of Frankford Arsenal from December 1, 1939 to June 30, 1942. He distinguished himself by marked executive ability and leadership in administering the affairs of this arsenal through the transition period of tremendous expansion following Pearl Harbor.

COL. RICHARD N. ATWELL, Elkridge, Md.—For service with the Ordnance section, North African Theater of Operations, and for exceptional meritorious conduct in the performance of outstanding services in North Africa and Italy from January 10 to November 19, 1944.

COL. LEMUEL P. CRIM, Columbus Junction, Iowa.—As commanding officer of the Savanna Ordnance Depot, Ill., from September 1939 to September 1942, with exceptional energy he brought that depot from a peace to a war footing. Personally supervising his crews despite great strain on his physical strength, he established effective coördination between the service-command establishments and depots in the vast area under his control.

COL. OSCAR KRUPP, Burlington, Vt.—For service from September 1942 to March 1944. As chief of the Policy Branch and as Acting Assistant Chief of Staff G-4, War Department General Staff, he displayed resourcefulness and military skill of a superior nature in formulating sound policies for the solution of logistical problems arising in the conduct of the war.

Colonel Crim

Mr. Bruce

COL. GEORGE A. MILLER, JR. (then Lieut. Col.), Philadelphia, Pa.—As Ordnance engineer at Frankford Arsenal, Philadelphia, he contributed in an outstanding manner to the development of incendiary small-arms ammunition and bullet-core steels, and to the technique of their manufacture.

COL. CLYDE H. MORGAN, Dayton, Ohio.—As Ordnance Officer, Wright

Colonel Miller

Colonel Rife

Colonel Grow

Colonel Stone

Field, Dayton, Ohio, and as chief, Ordnance Aircraft Service, Wright Field, from September 8, 1939, to January 17, 1944, with outstanding professional ability he either supervised or coöperated in the developments in aircraft ordnance which today make the American airplane so superlative in combat.

Col. Walter C. Pew, Gladwyne, Pa. —Upon appointment as chief of the Civilian Personnel Branch, Office of the Chief of Ordnance, on October 28, 1944, he at once initiated a survey of all Ordnance installations in the United States to determine the adequacy and efficiency of their civilian personnel administrative programs.

Col. Byron Rife (then Lieut. Col.), Baytown, Tex.—As commanding officer of the Missouri Ordnance Works from November 15, 1941, to September 15, 1942, he distinguished himself by marked executive ability and leadership in administering the affairs of this plant through the transition period of tremendous expansion following the outbreak of hostilities at Pearl Harbor.

Col. Phillips W. Smith, Madison, Wis.—For service as chief of the Ordnance section, Purchase and Contract Branch (later Contract Division), Office of the Under Secretary of War, from July 1940 to March 1942.

Col. Galen M. Taylor, Washington, D. C.—As chief of the Antiaircraft and Fire Control Branch of the Artillery Division, Office of the Chief

Colonel DeGuire

CWO Goss

of Ordnance, from June 1939 to May 1944, he directed the development and production of a combination fuze setter-rammer for the 90-mm. antiaircraft gun by means of which fuze setting and ramming are performed automatically. By his ingenuity he has made available to our Army an antiaircraft gun with more accuracy and an increase of twenty per cent in the rate of fire.

Lieut. Col. Rollin C. Boyles, Oklahoma City, Okla.—For outstanding services as officer in charge of the Vehicle Assembly and Storage Branch, General Supply Division, Office of the Chief Ordnance Officer, European Theater of Operations, from April 12, 1943, to October 15, 1944.

Lieut. Col. Durward E. Breakefield, Washington, D. C.—As chief of the gun division and as production manager at Watertown Arsenal, Mass., from November 1940 to May 1945, he

Colonel Krupp

Corporal Porter

assured the accomplishment of difficult production schedules beyond all expectations. Pursuant to his planning and under his efficient supervision, centrifugal casting of gun tubes, which hitherto had not been successful in the United States and abroad, was performed on a production basis.

Lieut. Col. Merlin L. DeGuire, Silver Spring, Md.—For displaying outstanding initiative from November 1940 to March 1945 in developing an engineering and inspection program for the manufacture of small-arms matériel.

Lieut. Col. Robert J. Grow, Crownsville, Md.—He was principally responsible for the preparation of the Ordnance standard operation procedure for Continental operations.

Lieut. Col. Jeffrey A. Stone, Elkins Park, Pa.—For service as officer in charge of the gage division, Frankford Arsenal, Philadelphia, Pa. He was largely responsible for developing glass

Colonel Taylor

Colonel Boyles

gages as a superior substitute for steel gages and energetically forcing their general application to industry.

First Lieut. Claude C. White, Birmingham, Ala.—For service in connection with the design, development, procurement, testing, and demonstration of a mine exploder.

THE following Ordnance officer has been awarded the Soldier's Medal:

Second Lieut. Orville D. Jaye, Garden City, Kans.—At Fort Jackson, S. C., on January 26, 1945, during hand-grenade practice a fragmentation grenade, with safety pin pulled, was accidentally dropped by one of the trainees. Lieutenant Jaye picked it up and threw it out where it instantly exploded. His prompt action at the risk of his life saved the life of one soldier and prevented possible serious injury to others.

THE following Ordnancemen have been awarded the Bronze Star Medal:

CWO Russell E. Goss, Fuquay Springs, N. C.—For meritorious service in connection with military operations in the European Theater of Operations.

Corp. Daniel R. Porter, Baker, Oreg.—With full knowledge of the hazards involved, he volunteered to act as a member of the armed guard of a ship which was dispatched on a vital and hazardous mission.

Lieutenant White

Colonel Atwell

New Mobile Artillery

Shown above are three ultranew self-propelled artillery weapons, hitherto secret, to increase the mobility and striking power of our ground forces. Left to right are the 155-mm. howitzer motor carriage M41, the 8-inch howitzer motor carriage T89, and the 155-mm. gun motor carriage M40. The M41, below, is fast traveling, has a low silhouette, employs the torsion-bar suspension.

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NOVEMBER-DECEMBER, 1945

Month by Month

Look Up, America!—Philosophers of history have long been interested in the problem of the progressive acceleration of the tempo of civilization in the Western world. In earlier centuries of the Christian era this change was relatively slow and gradual. There were, of course, wars, invasions, earthquakes, and other man-made or natural disturbances, but on the whole the pattern of life of the great mass of the people changed slowly, and population increases could be charted rather definitely.

Toward the end of the Middle Ages, many significant changes occurred: the widespread use of money as a medium of exchange, the development of the use of credit, and other financial techniques in the realm of finance; in the military field, the development of gunpowder and artillery; the invention of printing; the invention and use of new instruments to aid navigators; the rise of the factory system.

Still later, vast changes were introduced by the agricultural and industrial revolutions. Since that period, technology and inventions of all kinds have multiplied, bringing in their wake tremendous alterations in social life, economics, and politics. These alterations became more frequent and the alterations they caused more drastic and severe.

Today the world is a much smaller place than it was even a quarter of a century ago, for we have instantaneous exchange of ideas and faster methods of travel. Today we must be concerned with strange diseases in Africa that can be brought into this country by airplane in a few hours. Economic maladjustments anywhere are certain to affect our economy in a minimum of time.

Recent progress in the field of science has been particularly amazing. Changes, improvements, and modifications occur so rapidly that a new invention quickly becomes obsolete. This has been due, in large part, to the fact that Government has poured unlimited funds into certain technical fields and has organized many large groups of scientists to concentrate upon problems that had a military application. As a result of this intense work, our society is bound to suffer a large number of shocks, progressively, in the immediate future. Civilian walkie-talkies and vest-pocket radios are only a hint of the coming revolution in the field of communications.

In the military field, a pertinent illustration of the rapidity of change is the fact that the first atom bomb was obsolete by the time it was dropped on Hiroshima. An improved version was dropped on Nagasaki. That version is today probably obsolete. VT fuzes used in World War II are now obsolescent.

According to General of the Army H. H. Arnold, commander of the Army Air Forces, "We will produce within the next few years jet-propelled bombers capable of flying 500 to 600 miles an hour to targets 1,500 miles away at altitudes of over 40,000 feet. Development of even greater bombers capable of operating at stratospheric altitudes and at speeds faster than sound and carrying bomb loads of more than 100,000 pounds already is a certainty. These aircraft will have sufficient range to attack any spot on the earth and return to a friendly base."

The current dynamic progress in the field of science raises all sorts of important questions concerning our national defense. If the United States does not keep pace with this rapid change we may find ourselves, overnight, the victims of an atomic-rocket attack from another hemisphere. This condition necessitates the continuance of considerable Government spending in research and development with concomitant heavy taxes. It will necessitate holding together some of the scientific teams that performed miracles in this war. It will necessitate an annual weapons-replacement program and, perhaps, the modernization, as far as possible, of canned ordnance—particularly air-borne equipment—on some kind of a periodic basis.

The rapidity of change in the field of science will inevitably bring about vast changes in all military-training programs. It is going to be much harder for troops to use the new weapons without increased technical knowledge. The storage and transportation of new weapons developed by science opens up another broad field.

The modern army, to survive, must keep one foot in scientific laboratories and part of the other foot in industrial facilities planning for possible blitz production of the latest weapons in the event of a future emergency. Textbooks in military and naval academies ought to be of the loose-leaf variety so as to keep pace, in tactics, strategy, and logistics, with the rapid-fire progress in science.

Still another broad field will be the development of counterweapons to advances that will be made in other countries as well as our own. Everybody will soon have atomic bombs. These countermeasures must apply not only to the battlefield but also to the protection of our cities and

civilian populations. In World War II England supplied each of her civilians with a gas mask. In wars of the future, the civilian populations will have to be supplied with much more complicated gadgets to ward off worse weapons than gas.

If you want to let your imagination run wild, it is conceivable that the whole pattern of life in America may be drastically changed. One possible result is maximum decentralization—our large cities are too vulnerable. Another radical change would be to go underground as the Germans tried to do in this war. Perhaps we should move our industries away from our highly vulnerable coasts or invest in aircraft to get the population away from a threatened area in a hurry.

With modern science, Western civilization has a tiger by the tail and cannot afford to let go. Mental conditioning to rapid change is a must. Continuous research and development is a must, and changes must be made to keep pace with development in practically all fields of human activity—military and civilian.

Statesman and Administrator.—In Henry L. Stimson the Nation can boast of a citizen and statesman of the highest patriotism and ability. His retirement as Secretary of War after directing our military forces in their most difficult assignment emphasizes again the self-sacrifice as well as the sterling leadership of this great man.

To have served as Secretary of War twice under administrations a quarter of a century apart; to have filled the office of Secretary of State when an unheeding Nation would not listen to his clarion call for action against Japan; and to have filled countless other offices of vast responsibility are accomplishments seldom allotted to one man. The Army Ordnance Association salutes this venerable statesman and administrator in a special way.

The Association was honored some years ago to have him serve as its counsel. Now in his retirement we join with a grateful Nation in thanking him for a masterful job carried to full fruition. His influence for the common good will continue on through generations.

Atomic Bomb.—From Secretary Stimson's statement to the press on September 19, 1945, we quote the following excerpt:

"We do not yet know the full implications of the release of atomic energy in relation to future military strategy, but we do know that it is revolutionary. This will require the most careful study. We must not make early and easy assumptions that the days of armies and navies are over. We can be sure if war should come again that it would be awful in its sudden intensity, and we must never again allow ourselves to be caught in a state of complete unreadiness. And we can be sure that it will always be the duty of the citizens of these United States to share in providing for the country the power that we must have to carry out our responsibilities."

In these words a great statesman and far-seeing patriot presents a most excellent appraisal of war's newest weapon—the atomic bomb. From it one can draw these conclusions: We shall have armies, navies, and air forces as before. The principles of *strategy* will remain the same, but *tactics* will be profoundly influenced. Obviously the atomic bomb has greatly increased the striking power of airplanes. Hence their importance in war is likewise increased. It may well be that air power has now become the dominant power and that all others are auxiliary to it. At least the proposition is worth intense and prompt action.

In the atomic bomb is the best possible evidence that any childish thinking about science and scientists on the part of military men is a calamity of the first order. Unless our military leaders have the broadest vision and quick determination to go all out with science, the atomic age will catch them napping. Such a condition will mean the ultimate defeat of our country in another war.

Our conclusion is that there is no place in the lineup anymore for the bureaucrats who claim they know all the answers. Modern war more than ever will be won by alertness in all fields. As in the realm of the spiritual Christianity is our best preventative of war, so in the realm of the material science leads the parade.

Preparedness, Postwar.—The Army and Navy Munitions Board has resumed its important postwar assignment of planning for industrial mobilization in the event of a future emergency. This means that the Board will become one of the key agencies in the defense program to be adopted to safeguard the security of the United States after the present wartime military establishment is demobilized.

The Army and Navy Munitions Board was originally activated in June 1922 by the then Secretary of War and Secretary of the Navy to plan industrial mobilization for war purposes. It functioned under a letter agreement until July 1, 1939, when President Roosevelt signed a military order placing the Board under his direction and supervision as Commander in Chief.

The Board helped to formulate the Industrial Mobilization Plan of 1939 which was made available to the agencies later assigned the task of mobilizing the resources of the country for war. That plan was kicked around by the politicians and the theorists for several years—only the Industry-Ordnance team took it seriously.

After the start of the war the Army-Navy Munitions Board worked with the War Production Board and other agencies on current Army-Navy problems such as stock-piling strategic materials and determining priorities.

During the postwar period the Board will have a much bigger job than it had either before or during the war. It will have the tremendous responsibility in connection with the development of new weapons and of planning how they may be produced in quantity should the need arise. Some of these weapons were just coming into use when the war ended, and their full potentiality is not yet known. This will make industrial planning extremely difficult.

As a result of the increased responsibilities of the Board, the President has directed that a civilian executive chairman be appointed to assume active direction of its operations. The executive chairman will be named by the Under Secretary of War and the Assistant Secretary of the Navy in the near future. He will be a man of proven ability and probably one who has been active in industrial mobilization during the war. The Board will report directly to the President through the Secretary of War and the Secretary of the Navy.

The Council of National Defense

An Editorial

THE TIME has come to revitalize the Council of National Defense and make it a strong arm for security. There is crying need at the moment for a small, all-powerful, alert body which can bring to the conference table regularly and instantly in peace as well as in war the directing heads of the principal parts of the Federal Government. Just as Pearl Harbor will stand for all times as a stark example of the lack of coördination between the State, War, and Navy Departments, so can the Council of National Defense serve as a simple and effective cure for such a condition.

¶ The council was created by act of Congress on August 29, 1916, but it was not fully organized until March 3, 1917. Under the terms of the act the council was, among other things, charged with the "coördination of industries and resources for the national security and welfare" and with the "creation of relations which render possible in time of need the immediate concentration and utilization of the resources of the Nation."

¶ The membership of the council consists of the Secretaries of War, Navy, Interior, Agriculture, Commerce, and Labor. All that it needs to make it complete is the addition of the Secretary of State to its membership. There will be in existence then a group which, if it is willing to utilize its power, can solve the most vexing problem of the times. The council should be reëstablished at once, and its functions should receive top priority on the busy schedules of its members.

¶ Such a device, however, will be only as strong as the interest and determination of those who compose it. It should be apparent to all that the national defense must receive first consideration in all our deliberations and policies from now on. The work of the council should not be delegated to minor officials; its meetings must be held with the regularity of Cabinet meetings and, when emergency demands, take precedence over all else.

¶ In England there is an all-powerful body known as the Committee for Imperial Defense. Its membership comprises the opposite files of the Council of National Defense. The committee is much more inclusive and far more agile than our council ever was. The committee has been known to meet several times in one day during great emergency. We urgently recommend the prompt reëstablishment of the Council of National Defense under the chairmanship of the Secretary of State so that never again will we be caught off base by any enemy in whatever corner of the globe American interests may require our full, prompt, coördinated strength.

Association Affairs

ORDNANCE IN THE PACIFIC

Just before V-J Day, leading Ordnance officers in the Pacific met at the Western Pacific Officers' Club in Manila. Here Ordnance heads of most of the major commands in the Southwest Pacific attended a dinner which marked the last informal meeting of the group in that important theater. Brig. Gen. Jonathan L. Holman, Chief Ordnance Officer, U. S. Army Forces in the Pacific; Brig. Gen. John H. Woodberry, Chief Ordnance Officer, Sixth Army Service Command; and Col. Merle H. Davis, Chief Ordnance Officer, U. S. Army Forces in the Western Pacific, were hosts.

Most of the officers present served with distinction in the Pacific Theater during the major part of the war. Many have taken active parts in the affairs of the Army Ordnance Association in years past. A picture of the group is published on this page as of special interest to their many friends. Their work in bringing victory over Japan individually and collectively was

Ordnance officers in the Pacific area.

of the highest order. Those shown standing in the picture are: Cols. C. F. Buck, Jr., Eighth Army Service Command; Robert Sears, Ordnance, General Headquarters, SWPA; L. A. Skinner, Eighth Army Service Command; R. G. Butler, Jr., Sixth Army Service Command; M. H. Davis; R. K. Haskell, Ordnance Officer, XI Corps; H. R. Westphalinger, G-4 Section, General Headquarters, SWPA; F. A. Hansen, Ordnance Officer, First Army; C. R. Dutton, G-4, Burma-India Theater; W. M. Tisdale, Ordnance Officer, Far Eastern Air Service Command; L. S. Fletcher, Sixth Army Service Command; C. K. McClelland, Jr., Ordnance Officer, Base X; John Liddell, executive to Ordnance Officer, Sixth Army.

Those in front are: Lieut. Col. Nathan Chenault, European Theater of Operations Mission; Col. F. M. Humphries, G-4 Section, General Headquarters, SWPA.

Those seated are: Brig. Gens. J. H. Woodberry; J. L. Holman; W. A. Borden, War Department, General Staff Corps; Col. Sam Ritchie, Office, Chief of Ordnance, Washington; Brig. Gen. P. G. Blackmore, Sixth Army; Cols. G. W. Trichel, Office, Chief Ordnance Officer, U. S. Army Forces, Western Pacific; J. W. Freeman, Ordnance Officer, U. S. Army Forces, Pacific; W. E. Niles, Sixth Army Service Command; E. N. Kirsten, Ordnance Office, U. S. Army Forces, Pacific; Robert Blodgett, Ordnance Officer, Far Eastern Air Force.

COMMITTEE ON AIMS AND ORGANIZATION

The Gidney Committee on Aims and Organization of the Army Ordnance Association is making splendid progress. A proposed report drawn up by a subcommittee was forwarded to the presidents of all local chapters of the Association for study and approval. These officers in turn submitted it to their associates and directors of the local Posts. Replies have been received from all Posts, and a final draft of the report is now in preparation. It will be submitted to the board of directors of the Association for approval at a special meeting to be called late in November. Thereafter it will go to the general membership of the Association for its approval.

The aim of the Committee on Aims and Organization is to modernize some of the procedures of the A.O.A. and in general to raise its sights in order that industrial preparedness, again assuming a most important part of our national economy, may be furthered and brought to the attention of all the people of our country. The report proposes a new method in the election of officers, establishes an adequate organization at national headquarters, defines the place and scope of local Posts and national divisions, and emphasizes the newer concepts of industrial-mobilization activity which the Association will foster in years to come.

The general committee of which Colonel Gidney, a director of the Association and formerly president of the Pittsburgh Post, is chairman, consists of the presidents of all active Posts throughout the country. A subcommittee under Colonel Gidney's leadership, which has worked incessantly for the past six months, consists of R. E. Gillmor, president of the New York Post; Edward T. Gusheé, president of the Michigan Post; Col. James L. Walsh, a director of the national Association; and Col. L. A. Codd, secretary. The committee also had the advice of Brig. Gen. John Ross Delafield, counsel of the Association; Col. C. E. Davies, secretary, American Society of Mechanical Engineers; D. D. Blanchard, Society of Automotive Engineers; and James Cope, formerly of the staff of the National Automobile Manufacturers' Association.

FOR ORDNANCE SERVICE

The United States would have been in a bad way when the war began had it not been for the old-line arsenals like Picatinny, according to Brig. Gen. A. G. Gillespie, chief of the Industrial Service, Ordnance Department, who spoke during a ceremony at the arsenal at which he awarded the War Department's Emblem for Meritorious Civilian Service to thirty-four arsenal employees.

The ceremony was held at noon in one of the arsenal's large cafeterias. It was presided over by Col. M. W. Kresge, chief of the technical division of the arsenal. Col. W. E. Larned, commanding officer of Picatinny, also spoke and assisted General Gillespie in awarding the emblems and accompanying certificates.

The thirty-four persons who received awards are: Lester Box, Edward L. Brown, Charles E. Bryant, Manhart Cankes, Wilder R. Carson, Henry A. Coggin, William H. Davis, Harry E. DeFelice, Abraham L. Dorfman, Sgt. Thomas P. Everett, George S. Fichter, Arthur Fitzpatrick, James R. Goggin, William R. Hall, Mahlon W. Hazen, Sgt. William Kauf, Francis Kenstler, John H. McIvor, Mrs. Annie Mathews,

Samuel A. Meddaugh, Albert J. Phillips, Earle F. Reese, Elmer E. Ritzer, William E. Roach, Aaron Rodkin, Gilbert E. Rogers, Richard J. Rowe, DeWitt D. Sager, Reuben E. Stickle, Samuel A. Ungerleider, Pierre Varrato, Charles C. Wolfe, Leonard A. Zeek, and Robert A. Zeek.

PUGET SOUND POST

Under the direction of Robert Nelson, program chairman of the Puget Sound Post of the Army Ordnance Association, an unusual and valuable visit was made by members of the Post to the Bremerton Navy Yard, Wash.

Comdr. George P. McCready, planning officer for Ordnance at the Navy Yard, gave the main address at a dinner which was held in the City Club of Bremerton. Commander McCready, assisted by his staff, was also in charge of the tour through the yard.

Capt. A. E. Uehlinger, representing Rear Adm. R. W. Christie, gave some very interesting sidelights on the activities of the navy yard and also some of his personal experiences overseas.

Over one hundred members of the Post attended, including those who came many hundreds of miles from Oregon and Montana, and the trip proved of great value and inspiration to all who attended.

HONORARY MEMBERSHIPS

The Ordnance School, true to its traditions of leadership and thoroughness, continues to award an honorary membership in the Army Ordnance Association to the outstanding officer candidate in each graduating class. At the exercises held at Aberdeen Proving Ground, Md., on August 11th, 2nd Lieut. Graham T. Nixon received the award. At the exercises on September 22nd, 2nd Lieut. Thomas L. Bell, Jr., was so honored. The Army Ordnance Association extends a hearty welcome to these two new honorary members.

NECROLOGY

Col. Thales L. Ames, one of the Ordnance fraternity's finest and best-loved characters, died at his home in Cambridge, Mass., September 11, 1945. His military career was outstanding from the day he entered the Military Academy in June 1891 until his retirement from active service on September 30, 1933. In the list of his endearing qualities was his prowess on the football field. A famed center on the West Point team, he was chosen All-American center for two years by Walter Camp.

Thales Lucius Ames was born in Wisconsin in 1869. At West Point he was chosen first captain of the Corps in his first-class year. Following his graduation in 1895 he was appointed 2nd lieutenant in the Coast Artillery Corps and in 1898 successfully passed the stringent examination required for admission to the Ordnance Department in which he served through all grades from first lieutenant to colonel.

Since its organization in 1919, Colonel Ames had taken an active and leading part in the affairs of the Army Ordnance Association, having served until recently as a director of the Boston Post. His associates of the A.O.A. and all who knew him in civil and military life mourn the passing of a distinguished officer whose gentle manner and great loyalty to duty will keep the memory of him vivid through the years.

Francis O. Wyse, secretary of the Milwaukee Post and an official of the Bucyrus-Erie Company, died September 15, 1945, at Milwaukee, Wis. He had taken a leading part in Ordnance affairs in the Milwaukee area for many years, and his loss is very great to both the local Post and to the national Association.

Born in Salem, Mass., on May 4, 1897, Frank Wyse spent the early years of his life in Toronto, Canada. Following an educational interruption for service in the U. S. Navy, he graduated from Massachusetts Institute of Technology in 1919 with a degree in mechanical engineering. He later joined the Blanchard Machine Company, Cambridge, Mass., from which position he came to the Bucyrus-Erie Company in 1924.

In 1926 he took over the management of the publicity department. He was widely recognized as an industrial advertising leader, serving as secretary-treasurer and vice-president before being elected president of the National Industrial Advertisers' Association in 1937. He also served as president of the Milwaukee Association of Industrial Advertisers in 1932-1933.

Mr. Wyse became identified with the National Crushed Stone Association as a member of the board of directors of the manufacturers' division, serving in this capacity from 1934 to the time of his death. He was elected chairman of the directors for 1934.

In 1938-1939 he was chairman of the publicity committee of the American Road Builders' Association. In 1942 he became secretary-treasurer of the Milwaukee Post, Army Ordnance Association, which office he served efficiently and enthusiastically until illness forced him to relinquish his duties.

Frank W. Lovejoy, chairman of the board of directors of Eastman Kodak Company, widely known civic leader and member of the Army Ordnance Association, died at Rochester, N. Y., on September 16, 1945. He was chairman of Eastman Kodak's board during the war years and directed its great production facilities into development of photographic equipment and special apparatus for the armed forces.

Born in Concord, N. H., he received his B.S. degree from Massachusetts Institute of Technology in 1894. He joined Eastman Kodak Company in 1897 to take charge of making sensitive emulsion for films. He became vice-president in 1925, president in 1934, and chairman of the board in 1941.

Colby College gave him an honorary LL.D. degree at a convocation in 1937, honoring the martyrdom of abolitionist Elijah Parish Lovejoy, an ancestor. The Rochester Museum Association awarded to him its 1941 civic medal.

His company was in the forefront of Ordnance production in World War II. To him as the leader of that great enterprise all friends of our national defense are grateful.

Karl Yost, executive engineer for Warner Electric Brake Manufacturing Company, died September 18, 1945, at his home in Beloit, Wis. He had contributed in an outstanding way toward the success of the Ordnance production program and was well known among Ordnance personnel at arsenals and proving grounds.

For thirteen years Mr. Yost was an official of the Bendix Corporation at South Bend, Ind., and for seven years was executive engineer with the Warner Company. He was the company's principal liaison with the Ordnance Department to which he furnished automotive equipment for use on heavy-duty vehicles.

A sergeant in World War I, Mr. Yost was a member of the Army Ordnance Association and participated in many of its activities.

NOTICE also has been received of the deaths of the following members of the Association: E. W. Bickler, Moline, Ill.; W. E. Canniff, Evansville, Ind.; F. S. Dewey, Cincinnati, Ohio; C. B. Dorgan, Cleveland, Ohio; R. E. Field, Cincinnati, Ohio; J. R. Garrison, Dayton, Ohio; L. H. Gould, Toledo, Ohio; R. L. Graves, Coldwater, Mich.; O. B. Harmon, Detroit, Mich.; H. E. Mack, Chicago, Ill.; G. A. Martin, Cleveland, Ohio; W. R. Martin, Louisville, Ky.; E. J. Searles, Pittsburgh, Pa.; E. J. Smith, Branson, Tex.; J. F. Swahlstedt, Crystal Lake, Ill.; P. E. Thompsen, Lincoln, Nebr.; J. P. Tierney, Boston, Mass. To their relatives and friends, ARMY ORDNANCE, on behalf of the Association membership, extends condolences.

HYDRAULIC EQUIPMENT

Watson-Stillman builds a comprehensive line of hydraulic presses and equipment that meets the many and varied requirements of practically all major industries.

W-S presses include types for assembling, baling, bending, briquetting, cable covering, coining, dehydrating, embossing, extruding, flanging, forcing, ceramic and plastic molding, straightening, laboratory, stamping, testing, and vulcanizing, forming, drawing, blanking, etc.

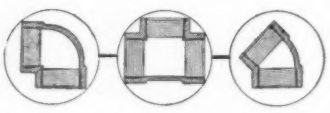
Watson-Stillman also builds accumulators, intensifiers, pumps, hand and power. Hydraulic Jacks, wire rope shears, pipe benders, forged steel fittings and valves.

FORGED STEEL FITTINGS AND VALVES

SOCKET WELD FITTINGS
For High Pressure, High Temperature Service

Machined from solid drop forgings. For use with Standard Pipe-Schedule 40; Extra Heavy Pipe-Schedule 80; and Schedule 160 Pipe, and Double Extra Heavy Pipe. Sizes ¼" to 4" I.P.S. Furnished in Carbon Steel; Carbon-Molybdenum Steel; Chromium-Molybdenum Steel or Stainless Steel.

SCREW END FITTINGS
For High Pressure, High Temperature Service



Machined from solid drop forgings. Available in three classes—2000—3000—and 6000 pound. Sizes ¼" to 4" I.P.S. Furnished in Carbon Steel; Carbon-Molybdenum Steel; Chromium-Molybdenum Steel or Stainless Steel.

THE WATSON-STILLMAN COMPANY
Factory and Main Office; Roselle, New Jersey, U.S.A.
Designers and Manufacturers of Hydraulic Equipment, Valves and Forged Steel Fittings

PROFESSIONAL DIGEST

THE RADIO PROXIMITY FUZE

Brilliant Army-Navy-Science-Industry teamwork beat the Germans to the punch in the mass production of a radio proximity fuze that ranks second in importance only to the atomic bomb and may, possibly, have been used in conjunction with the atomic bombardment of Japan.

From 1940 to 1945, the American team designed, developed, and manufactured 17,000,000 radio proximity artillery, antiaircraft, rocket, mortar, and bomb fuzes at a gross expenditure of $1,000,000,000. Army Ordnance, the Navy Bureau of Ordnance, the Office of Scientific Research and Development, 26 university and industrial laboratories, and a total of 87 firms using 110 different factories were engaged in the highly secret project. Approximately 100,000 Army-Navy Ordnance personnel, scientists, technicians, and workers took part in the all-out effort. The Germans, who had been working on forty varieties of a similar fuze since 1930, were unable to put even one fuze in action prior to V-E Day.

A VT (variable time) or radio proximity fuze explodes a projectile as soon as it comes close enough to a ground or air target to inflict damage. The first accepted fuze came from the production lines in September 1942, and the first Japanese plane to be shot down by a VT-fuzed projectile was destroyed by the cruiser HELENA on January 5, 1943.

Secretary of the Navy Forrestal recently declared that "the proximity fuze helped blaze the trail to Japan. Without the protection this ingenious device gave the surface ships of the fleet, our westward push could not have been so swift and the cost in men and ships would have been immeasurably greater."

In the preinvasion saturation bombardment of Iwo Jima, 1,100 VT-fuzed bombs were dropped, resulting in the complete neutralization of Japanese antiaircraft defenses on the island. In the air-sea battle off Okinawa, two destroyers, the EVANS and the HADLEY, employing VT-fuzed projectiles, knocked down thirty-five Japanese planes in thirty minutes.

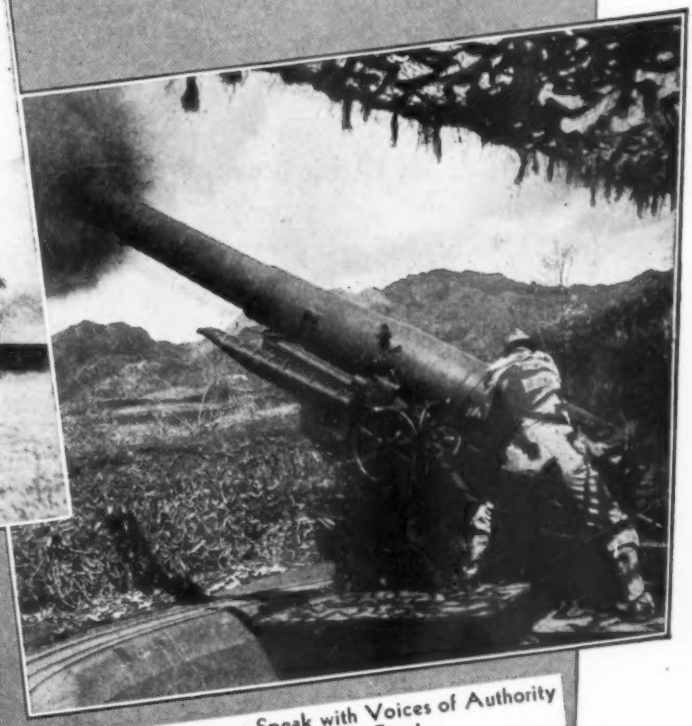
To safeguard all technical data concerning the revolutionary device, the Combined Chiefs of Staff prohibited the use of the fuze for land warfare until the summer of 1944—and then only on friendly territory. The invention was given to the British for use against German V-1 bombs. Its effectiveness was demonstrated particularly during the last four weeks of the 80-day attack. During the first week, American and British gunners destroyed 24 per cent of all V-1 targets, 46 per cent in the second week, 67 per cent in the third, and 79 per cent in the fourth week.

The amazingly accurate VT fuze was first employed on the European Continent in the Ardennes during the savage winter of 1944. It proved to be a major factor in the deadly artillery assault which drove the remnants of Von Rundstedt's forces back into Germany and smashed the *Wehrmacht's* last desperate bid for world domination. While the Battle of the Bulge was still raging, Gen. George S. Patton, Jr., wrote Lieut. Gen. L. H. Campbell, Jr., Chief of Ordnance, on December 29, 1944, as follows:

"The new shell with the funny fuze [a security designation] is devastating. The other night we caught a German battalion, which was trying to get across the Sauer River, with a battalion concentration and killed by actual count 702. I think that when all armies get this shell we will have to devise some new method of warfare. I am glad that you all thought of it first. It is really a wonderful achievement."

MESTA Produces in a Special Division Great Quantities of Heavy Guns Including the Largest Regularly Used by Our Armed Forces

155 mm. "Long Toms," the Heavyweight Champions of Modern Field Artillery



240 mm. Howitzers Speak with Voices of Authority on Every Fighting Front

ARMY E NAVY

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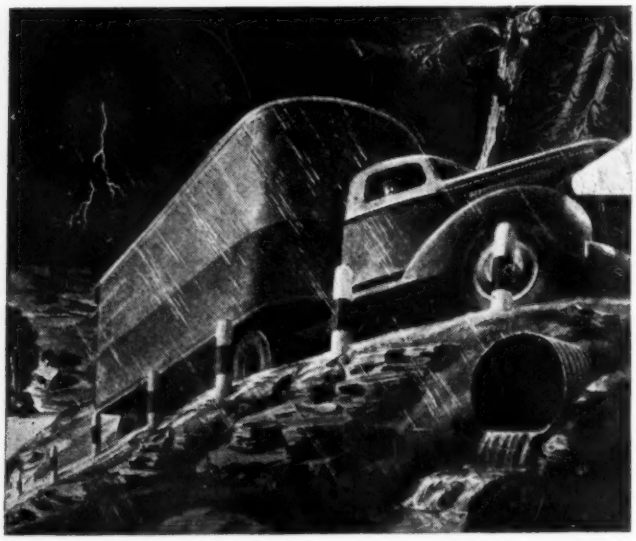
BUY EXTRA WAR BONDS



There must be no compromise with --Safety

Warner Vari-Load Electric Brakes are Safer!

In the months ahead, motor transportation faces a mighty task. Straining to meet unprecedented peacetime demands, American industries are in urgent need of equipment, machinery and supplies. Loads that fail to get through on time will not only upset production and sales programs for these industries—but mean losses in revenue to trailer operators. Delays due to accidents caused by ineffective brakes *must be prevented*—there should be no compromise with safety.

Protect your drivers, your cargoes, and your trailer outfits—give them the EXTRA SAFETY of *Controlled Braking Power*—exclusive feature of Warner Vari-Load ELECTRIC Brakes. No matter what the weather, the driver can pre-set any and all brakes to fit BOTH load conditions and road conditions—thus keeping his train straightened out and under full control even when the going is slippery. Costly tie-ups due to damaged equipment are therefore avoided.

On all future trailer purchases, *specify* Warner Vari-Load *Electric* Brakes—world-famous for safety, simplicity and dependable, trouble-free performance.

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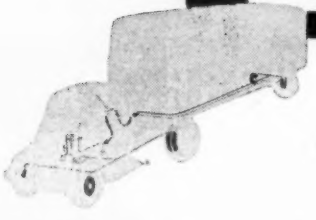
ELECTRIC BRAKES



Only a few flexible wires. Nothing to freeze or chatter—no complicated mechanisms.

Professional Digest

Five years ago the specifications that any useful proximity fuze would have to meet seemed prohibitively difficult and numerous. Its component parts would have to be rugged enough to withstand the terrific shock of being fired from a gun at an acceleration of 20,000 times the force of gravity, and it would have to withstand the centrifugal force caused by rotations as high as 475 a second.

The fuze would have to be operable day and night and be largely independent of weather conditions. It would have to be small, lightweight, relatively inexpensive, capable of rapid manufacture, and of such form as to be readily attached to existing projectiles. The device would have to be sensitive and rapid in operation but not subject to countermeasures by the enemy or to false operation due to such interference as gunfire and reflection from the ground, water, and clouds. It would have to be safe to handle, and not subject to rapid deterioration in storage.

Perhaps the most important requirement was that the fragments of the exploded shell should embrace the target. When a high-explosive shell detonates in flight the fragments are concentrated in a narrow area lying fifty-five degrees back from the nose of the projectile. To be effective, a proximity fuze would have to cause detonation of the shell at such a point in its trajectory that the target would be inside the area filled with lethal fragments.

THE VT or radio proximity fuze was the Army-Navy answer to all these problems. Essentially, the VT fuze is an extremely rugged "5-tube" radio transmitting and receiving station which fits into the nose of a projectile or bomb and is so compact that it displaces a volume less than that of an ordinary pint milk bottle.

While the projectile is in flight, high-frequency waves are radiated at a speed of 186,000 miles a second, thereby setting up a beat-frequency in the fuze circuit. When this frequency and its amplitude reach the values for which the fuze is adjusted and which assure that the projectile is close enough to a target to cause damage, the electrical impulse "triggers" the fuze and detonates the charge.

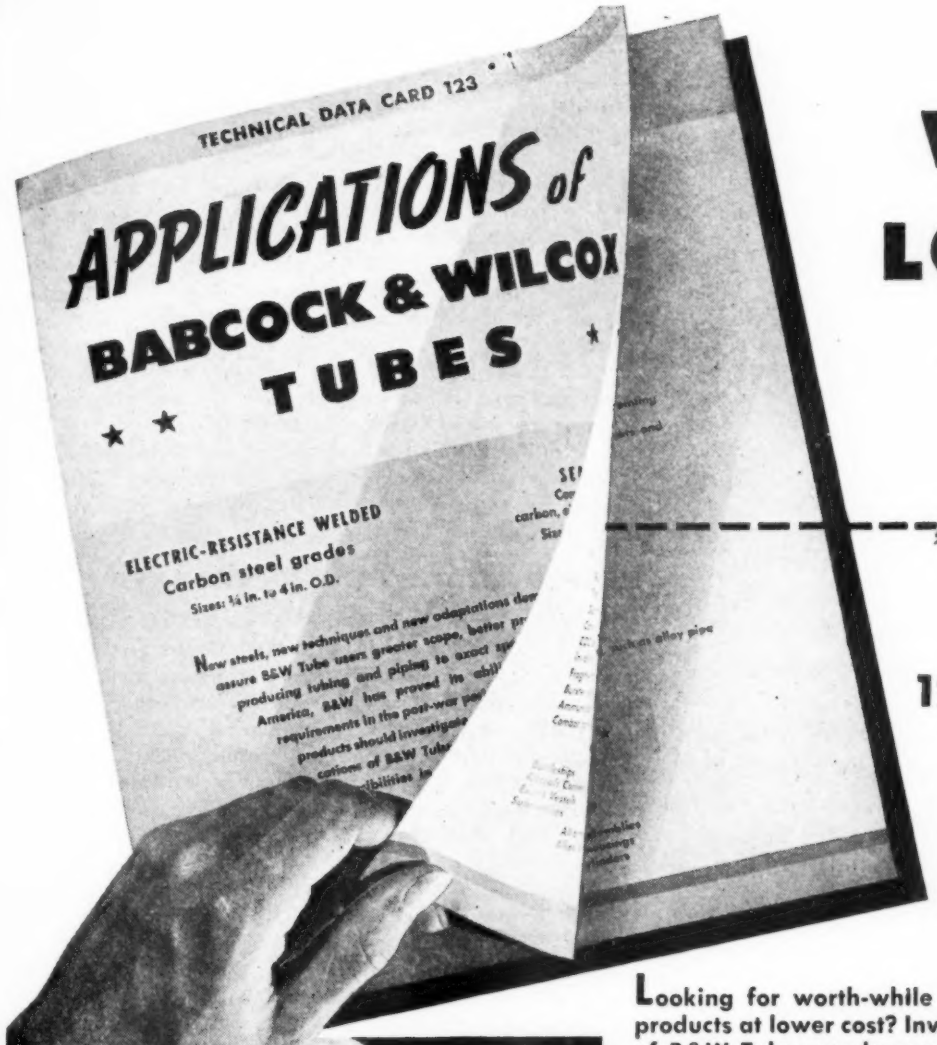
Artillerymen, ever since guns were invented, have desired an automatic fuze that would allow them to get air bursts over targets at a height which would give maximum fragmentation effect on enemy personnel hiding in trenches and foxholes or lying flat on the ground. When an ordinary high-explosive shell is fired with a point-detonating fuze, the shell explodes upon contact with the ground. Fragments and debris are hurled upward in an inverted cone. Enemy troops are not hurt unless the shell lands near them or close enough to injure them by concussion.

By exploding the shell in the air, approximately seventy feet above the ground, a storm of high-velocity shell fragments is directed at the ground that will kill or injure all enemy personnel in the area not under heavy protective cover. VT fuze air bursts "follow" the terrain, bursting at the same height from the ground over a hill as over a valley.

The VT fuze was developed at the precise time when the surface ship's traditional supremacy over the seas was seriously threatened by the airplane. It was clear that the problem of fleet protection demanded some method of improving naval antiaircraft firepower.

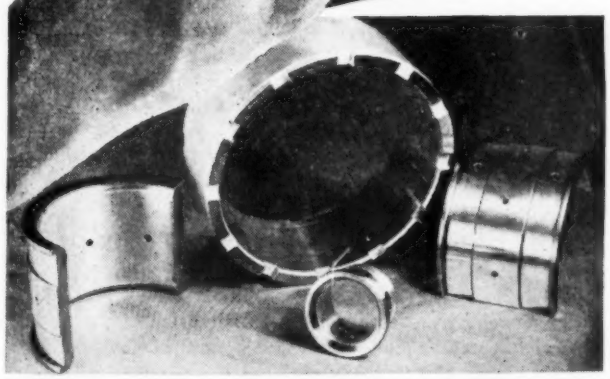
The new device, by automatically detonating a projectile when it reached the proximity of an enemy plane, eliminated the process of fuze setting, excluded the errors inherent in time-fuze mechanisms, and made possible maximum results at the split-second speed demanded by modern antiaircraft fire.

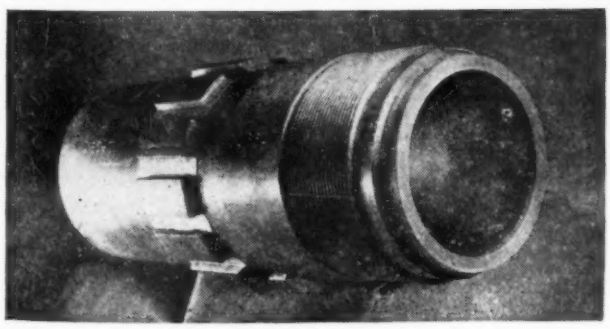
The buzz-bomb Battle of Britain and the successful antiaircraft defense of the vital port of Antwerp proved conclusively that VT fuzes were equally effective when employed by ground troops against air targets.



WORTH LOOKING INTO

120 Present Uses that suggest Future Savings





Looking for worth-while shortcuts to better peacetime products at lower cost? Investigate the many applications of B&W Tubes made possible through new steels, new techniques, and new adaptations of seamless and welded tubing demanded by the war effort.

For instance, many products and parts, once made from costly-to-handle bar stock, are now being made faster and cheaper from dimensionally accurate, easily-machined B&W seamless tubing.

B&W seamless tubes are made in a complete wide range of carbon and alloy steels including stainless—both straight chromium types of the ferritic group and those austenitic alloys from Type 304 up to Type 347. Sizes range from ½ inch to 8⅝ inch O.D.

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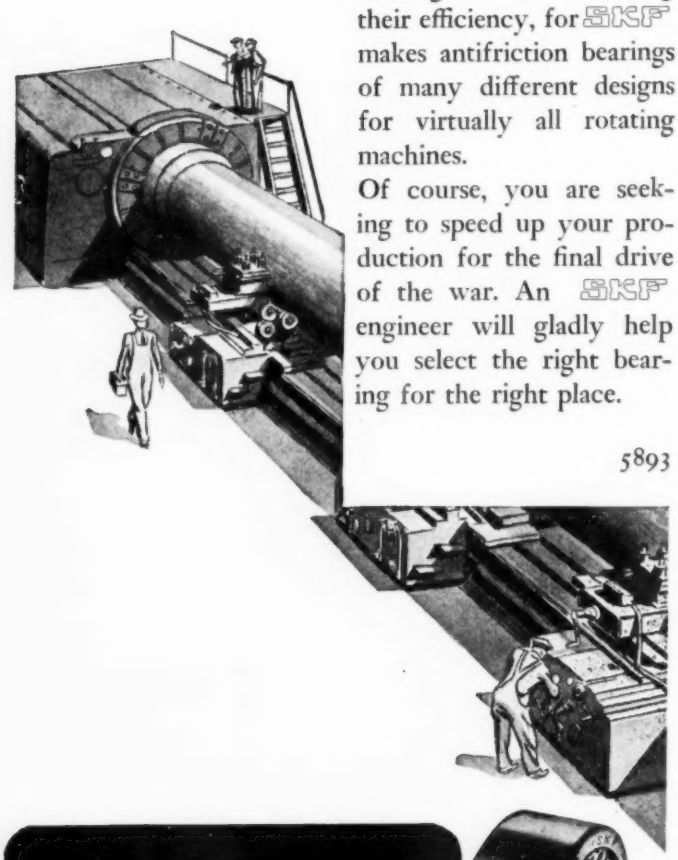

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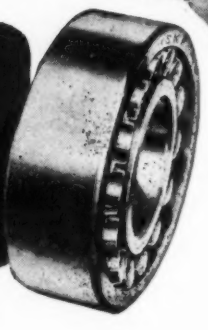

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The radio proximity fuze was also employed in the Army's air-borne 4½-inch rocket. Extensive tests demonstrated that one out of every two VT-fuzed rockets, fired from a fighter plane, could be counted upon to bring down an enemy airplane at 1,000-yard range. Since the usual fighter plane normally carries six 4½-inch rockets, a single plane could account for three enemy aircraft on each mission.

Army Ordnance will maintain continuity of research on the radio proximity fuze during peacetime. On July 23, 1945, General Campbell laid the cornerstone of a new half-million dollar Ordnance laboratory on the grounds of the National Bureau of Standards. The building will be completed in November 1945. A research contract has been consummated which offers unique advantages both to Ordnance and to the Bureau.

A scientific staff is now available at the Bureau which has had some years of experience in the new technology. This staff includes a number of eminent scientists in the fields of electronics, mechanics, and aviation.

KEEP MILITARY DESIGNS CURRENT

Before the smoke and anguish of the present conflict are dispelled by man's aggressive instincts to forget past errors in an effort to create a desirable future, before our vivid memory of mistakes and the conceived methods of correction pass into limbo, before the time passes when every one actively engaged in the process of war forgets those means which may be usefully employed to stay the instigation or forward the successful completion of the next war, it should be every one's duty to proclaim such ideas as may delay to the utmost the next military conflict.

The solution to the problem is simple; the means by which the solution may be realized can be simple but are considered complex. The immediate availability of up-to-the-minute designs for military equipment is the solution. No power in the world can hope to maintain, with intelligent economy, up-to-date military material sufficient for wartime needs. But with intelligent and economic effort there can be maintained, in tested form, the designs from which proper equipment can be efficiently made.

From the beginning of time man has constantly used his intellect to relieve requirements upon his physical abilities. At various intervals military combat has been considered an unavoidable requirement. At such times recourse has been had to the latest available mechanical means, hastily adapted to imminent or existing warfare.

Logically, due to the haste required, the military evolutions of well-developed commercial techniques and processes are always inferior to those possible from sustained development. With the progress of civilization and its ever-increasing means to satisfy man's physical requirements, it is natural that military tactics and operations become more and more mechanized in character until, at the present time, one distinguished British soldier has stated as his belief that ninety-nine per cent of a unit's combatant strength depends upon equipment—most of which is mechanical in character.

The greatest and most urgent need at the beginning of the conflict now concluded was military equipment—a great portion of which was mechanical. All those intimately connected with the production of this equipment will remember the inadequacy and obsolescence of the designs from which it was presumed this material could be made. The greatest tribute, which will never be accorded, belongs to those manufacturers who made the wrong designs quickly in order to produce for a desperate need.

The fact that more billions were wasted on obsolete and inadequate designs than would have provided intelligent peacetime military design and development work for decades to come argues that this tragic mistake should not be made again—as it probably will be.

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The power that's there when you need it most...the push of a button and it's ready to go to work. As for control! Why! Hobart generators are noted for their fine, close control of the current they produce. "Simplified" controls too...take Hobart Arc Welding Generators for instance, with Multi-Range Dual Control it's possible to get 1,000 combinations of voltage and amperage without a single dead spot. Is it any wonder that the maintenance crews of our armed forces and home front like Hobart Power? *ASK US ABOUT IT.*

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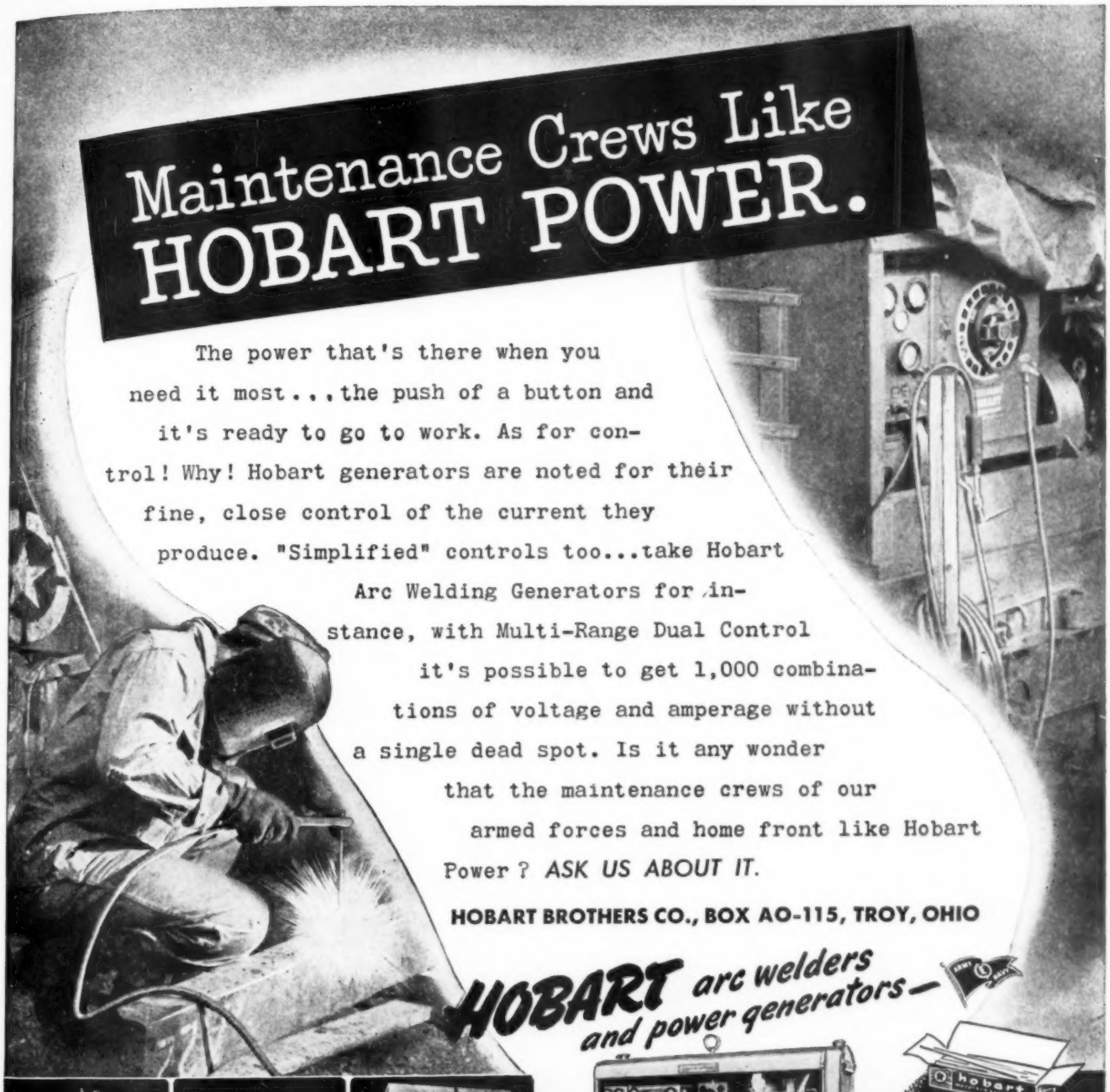

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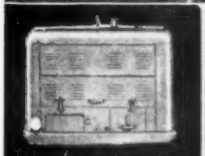

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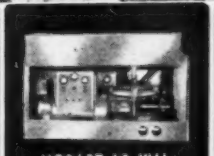

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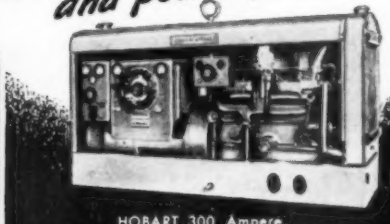

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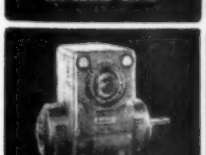

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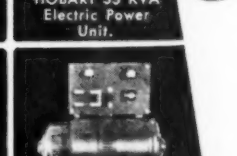

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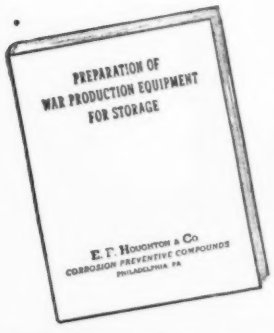

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Professional Digest

Two general classes of organizations, separately or in combination, might be presumed capable of accomplishing the immediate availability of up-to-the-minute designs for military equipment. They are the military forces and civilian manufacturers. If the historical attitudes of these groups persist, neither the one nor the other will make the least headway toward the desired solution. The reasons behind this statement are generally as follows:

The military forces maintain the traditional military viewpoint which dictates that orders be issued without discussion or the evolutionary development required to produce efficiently the proper types of mechanical equipment. For combat service this procedure has often best met the needs of immediate emergency, but Mother Nature—the parent of all things mechanical—will not come to heel at peremptory military commands.

The military are often not conversant with the latest methods and techniques of manufacture and therefore cannot formulate designs which efficiently utilize these advantages.

Civilian manufacturers, on the other hand, are primarily interested in producing commodities for profit. The long-range viewpoint of war's disruption is easily forgotten until too late for the instigation of proper programs to insure against it. They are not conversant with the needs of the military.

Manufacturers do not like to be told how to run their own business by those whom they consider amateurs in that field. They are receptive to problems in which the end requirements are stated but not to projects in which the minutest detail is specified and the end result criticized.

BUT the underlying reactions just noted are, as mentioned, "historical" and are subject to change. Since the armed forces should be responsible for the immediate availability of up-to-the-minute designs for military equipment, why cannot the "historical" methods—which I am sure every one agrees did not produce efficiently in the recent emergency—be consigned to the Potomac and means initiated to inform industry how to produce war material efficiently and economically and have immediately available the finest designs of military equipment ever conceived?

There exist in this country the finest mechanical minds and the finest mechanical equipment on earth. World War II demonstrated the outstanding tactical skill of our military commanders. Should these agencies really get down to brass tacks in the formulation of a program to maintain our armed forces at maximum practical readiness for war, and on this basis gain the required support of the Congress and the people, the next armed conflict would be deferred to the maximum.

Cannot the armed forces realize and admit that mechanical equipment is the prime outstanding essential of modern or future warfare? Can they not realize that the design, development, and continued improvement of such material must be evolved on the basis of the most efficient current manufacturing techniques and not by virtue of an order to a military design section whose chief contact with industry is the daily newspaper?

In order to acquire the necessary up-to-date basic information, could not selected officers of the armed forces be placed in leading manufacturing establishments, not on any type of sabbatical tour, but to roll up their sleeves and do a job and, in so doing, acquire the skills and know-how so absolutely essential to the proper design of modern equipment of any type?

Would not military personnel, given the above training in addition to their military contacts, be in a position not only to design military equipment properly but also to develop manufacturing contacts which would enable our Government to produce, quickly and efficiently, the materials it would urgently need in time of national emergency? I believe so, and I fervently hope so!—WILLIAM MANNING, *assistant chief engineer, Pontiac Motor Car Company, Detroit, Mich.*

YORK VAULT REMAINS INTACT

Bank of Philippines Building Demolished

When Yank troops reëntered Manila they found that the bombs, artillery shells, and fire which had razed the building housing the Bank of the Philippine Islands had no effect on the YORK VAULT which stood firm and unopened during more than two years of Japanese occupation and many bombardments. Pictured at right are a U. S. Army officer (left) and an official of the Bank who found the contents of the YORK VAULT intact after it had been opened by Army Engineers. Under most severe conditions, records and valuables necessary to the reëstablishment of the Bank were fully protected by this YORK VAULT installed in 1923.

York Craftsmanship made possible the story above—the same Craftsmanship that was for over five years devoted almost 100% to the manufacture of guns, gun mounts, tank parts, fuzes, shells, and many other Ordnance items for the U. S. Army and Navy.

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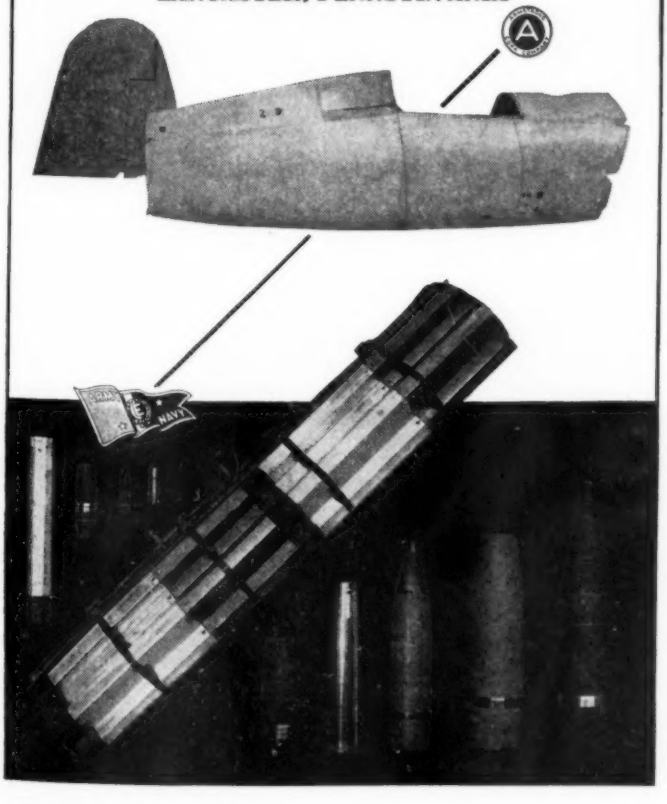

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Machine Guns

U. S. Machine Guns, 1895-1944, Part III

Maj. B. R. Lewis

IN this installment of his series of articles on machine guns being written exclusively for ARMY ORDNANCE, Major Lewis begins a discussion of the postwar development of the various types of Brownings. Part I of the series appeared in the July-August 1945 issue and Part II in September-October. When completed, this series will be an authentic account of all the official models of U. S. machine guns from the first caliber .30 weapon up to 1944.—EDITOR.

Browning Caliber .30, Model 1919 (Ground Type).—In 1919, the Remington Arms Company, Ilion, N. Y., made five specimens of a new gun, designated Model 1919 (Idealized), incorporating improvements in the Model 1917 suggested by Remington and the Bridgeport Ordnance District. Principal novel features were: rear sight on the top plate rather than on the cover, changes in threads to eliminate water leakage from the jacket, and stronger side and bottom plates. This new gun never went into quantity production.

The Model 1919 aircraft gun, to be described in detail later, incorporated these improvements, but the large stock of Model 1917 guns on hand precluded for many years the making of new ground-type guns. However, the data obtained in evolving the Model 1919 were of considerable use in the later development of the caliber .50 machine gun.

Browning Caliber .30, Model 1917A1.—Our standard water-cooled gun for ground use is a refinement of that which proved its worth in World War I. During that war, certain defects in the Model 1917 were revealed. Weaknesses of the bottom plate—the only one of any consequence—was caused by poor material rather than faulty design. It was overcome by providing a reënforcing stirrup on the outside of the receiver. In fiscal year 1920-1921, 25,000 of these stirrups were made, and guns being placed in storage were modified by the addition of this improvement.

The Model 1917 gun was designed to operate against ground targets with Model 1906 ammunition. It became necessary to adapt the gun firing on either ground or aërial targets with M1 or M2 ammunition. In 1936, a review was made of the development status of the caliber .30 Model 1917 water-cooled machine gun, and a complete remanufacturing program was instituted at Rock Island Arsenal. Among the changes made were: a new bottom plate, feed lever, and mounting; an improved cover-latch assembly; and graduating of sights for the new ammunition. This gun is known as the Model 1917A1 (Plate 8).

Guns of recent manufacture incorporate additional minor changes and improvements, such as substitution of steel for bronze in several parts; improved steam tube, bunter plate, and barrel gland assembly; and a recoil plate similar to those used in the calibers .30 and .50 M2 guns. The M1917A1 can be identified by the new bottom plate which differs materially from that of the Model 1917.

An effective and outstanding use of Public Works Administration funds occurred at Rock Island Arsenal in connection with the remanufacture of the 1917 guns. Parts for more than 35,000 guns were manufactured from War Department funds. P.W.A. funds were used for labor and other facilities that were non-military—in compliance with P.W.A. restrictions—such as, dis-

Major Lewis is assigned to the historical section, Office of the Chief of Ordnance.

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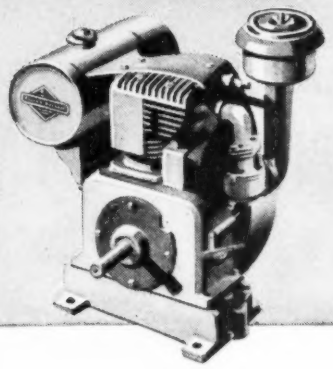

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assembly, assembly, and preparing finished guns for field-service storage. This work employed thousands of people from the three cities adjacent to Rock Island, and the result of their combined effort with Rock Island Arsenal constituted one of the greatest single factors in saving England in her critical hours.

Browning Caliber .30, Model 1919 (Tank).—The Browning machine gun, Model 1919, air-cooled, was developed expressly for tanks. It was the basic design from which the succeeding M1919 models have been evolved. It was equipped with a flexible

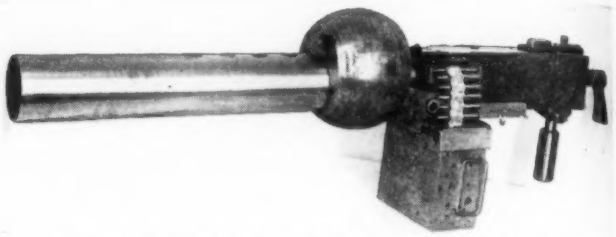

Fig. 12. Browning Tank Machine Gun, Model 1919

ball mount (Fig. 12) and an emergency mount consisting of a short tripod for ground use. This gun had an air-cooled, heavy, 18.63-inch barrel and a shoulder rest to facilitate firing from the flexible mount. The mechanism was interchangeable with the Model 1917. It was equipped with front and rear telescope sight brackets. For ground use a tubular rear sight was made integral with the rear bracket, and a front sight was fastened to the front bracket.

By June 30, 1919, 72,500 Model 1917 and 1,306 Model 1919 Brownings—both standardized for issue—had been manufactured. During fiscal year 1920, 500 more Model 1919 were made, and 800 of the Model 1917 were converted to Model 1919.

Browning Caliber .30, Model 1919A1.—In the first attempt to use the Model 1919 gun for ground troops the Model 1919A1 was developed. This was the same as the 1919, except that the telescope sight brackets were removed, the tubular rear sight was mounted in place of the rear bracket, and the front sight was placed on the trunnion block. First known as the 1919E1, this gun was made a limited-standard type on October 22, 1931.

Browning Caliber .30, Model 1919A2.—Minor changes in the 1919 gun were incorporated in the Model 1919A2, a light machine gun for cavalry and certain combat vehicles (Fig. 13). Principal changes were in the back plate and sights. A carrying strap was added, and a special hand grip and trigger were attached. The tripod had no elevating mechanism, and the tubular rear sight was replaced with a new sight mounted on the latch. The front sight was placed on the jacket, making it impractical to mount this type in tanks.

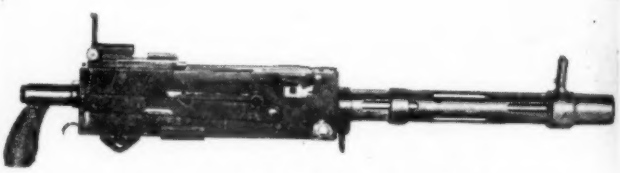

Fig. 13. Browning Light Machine Gun, Model 1919A2

Browning Caliber .30, Model 1919A3.—For special Infantry Board tests, seventy-two machine guns, Model 1919A3, were made. Superficially, this gun resembled the Model 1919A2. The front sight was removed from the jacket, a hole was drilled in the latch knob as an auxiliary rear sight, and there were other minor changes in an effort to make it suitable for armored vehicles, tank, cavalry pack, and ground use. Tests showed that it did not meet all these requirements. (*Continued on p. 448*)

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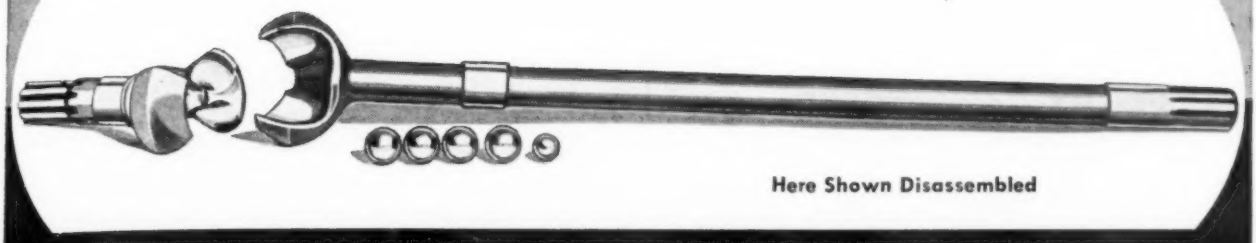

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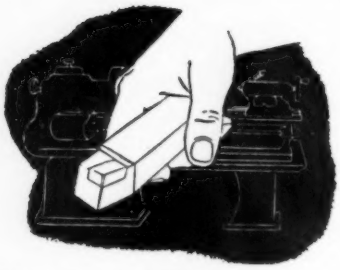

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Machine Guns

Browning Caliber .30, Model 1919A4.—In 1924 development was started to improve the cooling and ballistic characteristics of the tank gun by using a longer, heavier barrel, with suitable radiating fins. The result was the Model 1919A4 (Fig. 14) in which barrel length was increased from the 18.63 inches previously standard for all the Model 1919 series to 24 inches. The barrel was redesigned and other improvements made, including a new longer barrel jacket, rear sight on the cover latch, and rigid front sight on the trunnion block. An elevating screw bracket was added.

Fig. 14. Browning Machine Gun, Model 1919A4

Guns of new manufacture differ somewhat from the original model. A new bottom plate is used which combines the separate stirrup, elevating bracket, and bottom plate of older models. The rear sight is mounted on a bracket fastened to the left side of the receiver, and the front sight is hinged. The rear-sight bracket includes the mounting and holes for a telescopic sight.

This model became the standard light machine gun for general use in combat vehicles and for cavalry. It is issued in both fixed and flexible types. The fixed gun, mounted as a unit with a 37-mm. or a 75-mm. gun, is used only for tanks. The flexible gun, used in combat vehicles or as a ground gun, has a pistol grip. A light tripod, caliber .30 M2, is carried in each tank for emergency use on the ground.

Browning Caliber .30, Model 1919A5.—The Model 1919A5 machine gun is an adaptation of the Model 1919A4 for coaxial mounts in light tanks. It is essentially a fixed gun with a special bolt-retracting slide.

Browning Caliber .30, Model 1919A6.—The most recent modification of the Model 1919A4, for infantry use, is the Model 1919A6 which incorporates a pressed-metal shoulder stock, a carrying handle, and a bipod similar to that used with the Browning automatic rifle. This results in a light machine gun—classed as substitute standard—suitable for air-borne troops as well as for general use. Though the barrel of this gun weighs 2.5 pounds less than that of the 1919A4, the two are interchangeable. This model was made a substitute standard on April 10, 1943.

Browning Caliber .30, Model 1918MI (Aircraft).—The Browning Model 1918 aircraft gun did not prove satisfactory. The mounting requirements were not met, and there were serious functional defects. By June 30, 1921, 3,067 of these guns had been modified at Springfield Armory to produce the Model 1918MI. Changes included an adapter to fit the ball mount used in planes, an operating handle and slide, a new firing mechanism, and minor alterations.

Browning Caliber .30, Model 1919 (Aircraft).—While the Model 1918MI was satisfactory, it was in no sense a production model. In order to add certain minor improvements and to place the design in condition for quantity production in case of an emergency, plans for a new gun were made. This was known as the Model 1919, of which a few were manufactured at Springfield Armory. In 1943, remaining Models 1918MI and 1919 aircraft guns were declared obsolete. (*To be continued.*)

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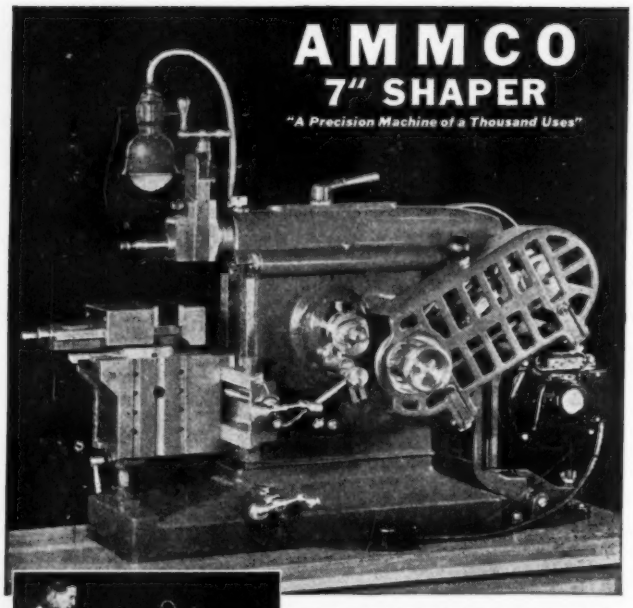

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ARMAMENT AND HISTORY. By Maj. Gen. J. F. C. Fuller, C.B., C.B.E., D.S.O., British Army, Ret. New York: Charles Scribner's Sons. 207 pp. $2.50.

THIS is the series of articles published in ARMY ORDNANCE between July 1944 and July 1945. They attracted wide attention at the time and their availability now in book form will add greatly to their popularity.

It is unnecessary to give here an analysis of the scope of General Fuller's text since all of it, with the exception of an introduction, appeared verbatim in these pages. But each passing day since the end of hostilities in World War II emphasizes again and again the truth of General Fuller's thesis. In it he examines "the things man fights with and how throughout the ages these things have influenced history."

The publishers deserve a special word of thanks for making these articles available in book form. There is no more vital topic on which the American people should be constantly alert. Here is the wisdom of the ages packaged so that all who run may read.

PISTOL AND REVOLVER SHOOTING. By Walter F. Roper. New York: The Macmillan Company. 256 pp. $2.49.

WALTER ROPER knows his guns. No one who peruses the fourteen short chapters of his new book, or any part of them, can honestly hold otherwise. For this is a volume written by a man who has plainly learned his stuff the hard way and with whom it would be unsafe to start an argument unless you were super-sure of your facts.

I hold that the fundamentals of shooting—any kind of shooting—cannot be learned from a book. But once these have been gained in the bitter field of experience many of the refinements of the game can be acquired from perusal of the written word. And if any one knows more of said refinements than does Roper, I challenge him to come forth and prove it.

Of works on pistol and revolver shooting there have been, in view of the relatively limited interest in this sport, a very considerable number produced during the past twenty years. Without consulting the record, and thus probably omitting some items, I recall the publication in the United States, since 1925, of books in this field by Himmelwright, Hatcher, Frazer, FitzGerald, Askins, Fischer, and McGivern. Adding the present publication, this gives us a volume on pistol and revolver marksmanship every 2½ years. Query: Do new developments in this field occur often enough to warrant such frequency of publication?

Perhaps not. But new treatment of old material plus the addition of a few freshly gleaned nuggets may yield, in the hands of an expert, a bountiful reward. And while I find nothing revolutionary in Roper's little book, I do find a great deal that is worth while. For Roper has contributed so much to bringing out the inherent accuracy of modern handguns through improvements in their stocks and sights that he is uniquely fitted to impart to his readers the significance of having both of these *exactly right*.

In the last analysis, the object of firing a bullet is to hit something, and his description of various readily practicable measures which materially increase the chances of this merits our careful attention.

Roper makes it plain that we can get better results with good tools than with poor or mediocre ones, explains why the good tools do the job and how to get the most out of them. He tells

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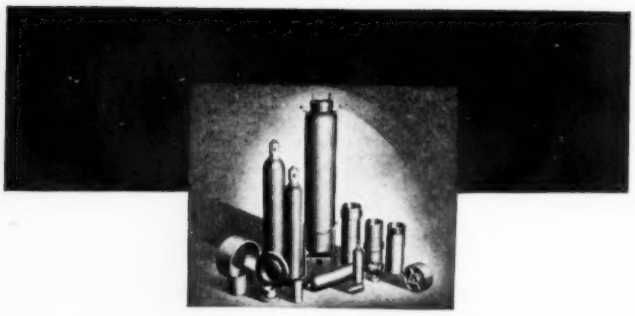

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his story simply and entertainingly. To my mind, this is one of the few really worth-while books in the firearms field to appear during the present war.

Roper's comments on the characteristics of all our current target handguns are so pertinent that I marked many of his passages for rereading. For instance, he decries the fact that the Smith & Wesson Military and Police Model is not made with a heavier barrel, and points out that so equipped it would "meet the desires of present-day shooters and undoubtedly become the choice of many of the finest shots."

It is hoped that the Messrs. Smith and Wesson will give heed to this observation and produce a heavy-barrel and hence more target-worthy variety of this grand old weapon. Again, he shows how a simple change in the design of the hammer of the S. & W. caliber .34-44 "Outdoorsman" revolver would render this arm infinitely more effective in rapid fire. Once more let me express the hope that the makers will not remain insensible to his apt and constructive criticism.

Rifle shooters know that Springfield caliber .30 Model 1903 rifle receivers made at that arsenal and numbered under 800,000 lack modern heat-treatment, so they shy away from them. In like manner pistol shooters are wary of early specimens of the Colt single-action Army revolver, hesitating to fire powerful smokeless loads in these. Roper gives us the serial number—160,000—which divides the sheep from the goats in this instance, the first time that I recall seeing this important datum in print.

IN the chapter on the American single-shot pistol we learn that "the fate of the single-shot was sealed when matches calling for three different kinds of fire—slow, timed, and rapid—became the thing." And later, "from the manufacturer's point of view the single-shot will never be of interest, for even in the days of its greatest popularity the number sold was not sufficient to warrant the cost of tooling up to make a really fine gun."

Yet, since "machine-rest tests of the two types of arms show that the inherent accuracy of the single-shot is decidedly greater than that of either the automatic or the revolver," it would seem that something could and should be done to keep the single-shot alive.

Perhaps the recrudescence of interest in firing single-shot *muzzle-loading* weapons, which has now persisted long enough to prove that it is no flash in the pan, may suggest that there still exist, even in these days of rocket propulsion, enough Americans willing to sacrifice speed for accuracy to assure a future for the single-shot. This reviewer devoutly hopes that this will prove to be the case.

Another bit of information which Roper conveys concerns the minor differences in chambering and rifling the barrel of the Smith & Wesson .22 double-action single-shot target pistol which resulted in changing its name, once these had been introduced, from "Perfected" to "Olympic." Most shooters have only the vaguest of ideas as to the variations between the two, and, for those curious to learn them, the answer is on p. 99. The solution to yet another mystery, the failure of the S. & W. .22 "Straightline" single-shot pistol to achieve popularity, is unfolded on pp. 100-103.

Roper indicates (pp. 142-143) that an orthoptic disk should be a part of every shooter's range equipment. Tsk, tsk! In my time these were considered fancy gadgets suitable only for the use of venerable graybeards who were half blind in one eye and couldn't see from the other. Time surely marches on!

Since Roper's prime specialties are stocks and sights, it is not surprising that the chapter on the first of these is close to being the longest in the book. I shall not attempt comment other than to say that every word of it is worth while and to confess my backwardness with respect to developments in that field by acknowledging prior ignorance of "wrist-lock" stocks for auto-

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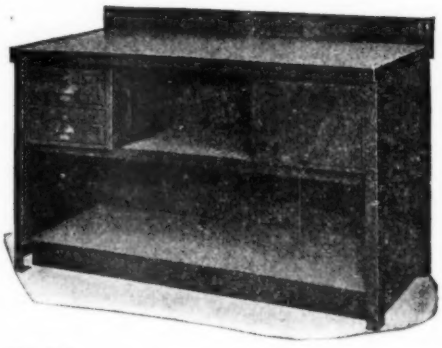

Fig. 1728

"Hallowell" Bench with backboard, one two-drawer tier, one receding door cabinet and lower shelf.

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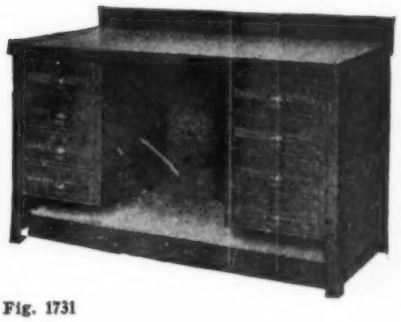

Fig. 1731

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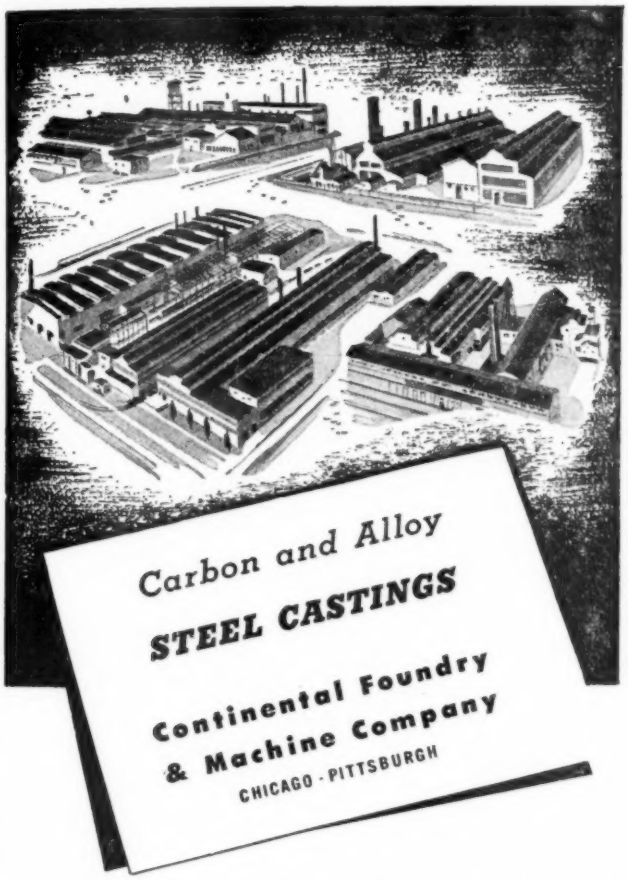

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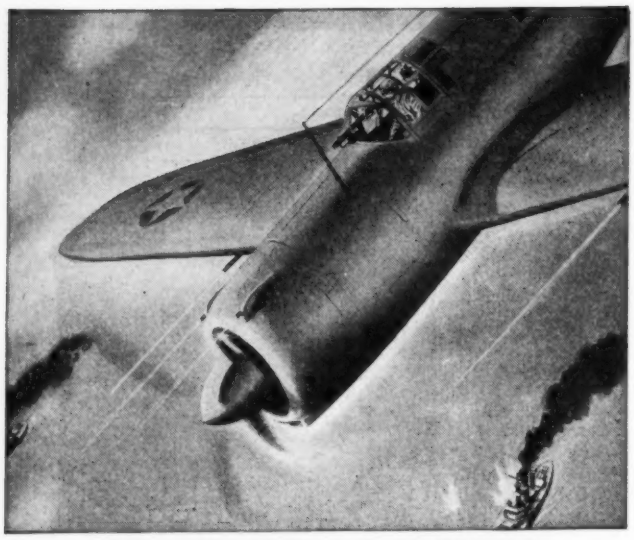

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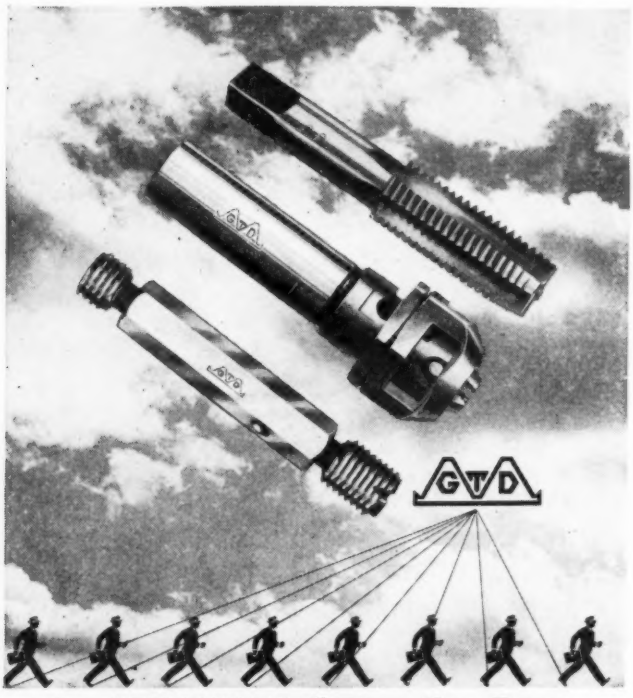

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Book Reviews

matic pistols, ingenious (and practical) contrivances described on p. 172. The chapter on sights, which follows, is equally brimful of valuable information and merits the most careful reading.

Additional hundreds of words could readily be devoted to comment upon interesting features of this volume. But enough has now been said to indicate that we have here a really significant work. The year 1945 has already yielded one splendid contribution to the literature—Townsend Whelen's book, "Small Arms Design and Ballistics." To have this followed so closely by another of similar quality is a stroke of good fortune which small-arms enthusiasts could scarcely have expected.

I take issue with Roper when he says (p. 120) that: "Tests [in 1890] proved conclusively that they [Smith & Wesson hammerless caliber .38 revolvers] were superior to the then-standard service revolver." I have read the report of those tests and while the .38 S. & W. showed certain superior characteristics, it manifested others which were far from desirable. Indeed, tyro that I am compared with Mr. Roper, I should be willing to go up against him in a 50-yard match armed with the service pistol of that day against him with his .38 hammerless, and place a modest wager that I would come off winner. (No Roper stocks or sights on the S. & W., please!).—Lieut. Col. Calvin Goddard.

Books Received

Album of American History (1783-1853). By James T. Adams. New York: Charles Scribner's Sons. 418 pp. $7.50.

Big Business in a Democracy. By James T. Adams. New York: Charles Scribner's Sons. 291 pp. $2.75.

Persian Gulf Command. By Joel Sayre. New York: Random House. 140 pp. $2.

Atomic Energy for Military Purposes. By Henry D. Smyth. Princeton: Princeton University Press. 264 pp. $1.25.

Salesmen for Tomorrow. By David R. Osborne. New York: Harper & Brothers. 225 pp. $3.

Budgeting for Management Control. By Floyd H. Rowland and William H. Harr. New York: Harper & Brothers. 378 pp. $4.

United Nations Government. By Amos J. Peaslee. New York: G. P. Putnam's Sons. 183 pp. $2.

Air News Yearbook. Edited by Phillip Andrews. New York: Duell, Sloan & Pearce, Inc. 296 pp. $4.75.

Advertising: Theory and Practice. By C. H. Sandage. Chicago: Richard D. Irwin, Inc. 747 pp.

The U. S. Marines on Iwo Jima. By five official Marine Corps combat writers. Washington: *The Infantry Journal*. 312 pp. $0.25.

This Is Where I Came In. By Robert J. Casey. New York: Bobbs-Merrill Company. 307 pp. $3.

The Killing of the Peace. By Alan Cranston. New York: The Viking Press. 304 pp. $2.50.

Old Leatherface of the Flying Tigers. By Keith Ayling. New York: Bobbs-Merrill Company. 274 pp. $2.50.

A Bibliography on Cutting of Metals. New York: The American Society of Mechanical Engineers. 547 pp.

Brave Men. By Ernie Pyle. New York: Grosset & Dunlap. 328 pp. $3.

Selected Speeches and Statements of General of the Army George C. Marshall. By Maj. H. A. DeWeerd. Washington: *The Infantry Journal*. 263 pp. $2.75.

Woodrow Wilson and the Great Betrayal. By Thomas A. Bailey. New York: The Macmillan Company. 429 pp. $3.50.

Mitchell—Pioneer of Air Power. By Isaac Don Levine. New York: Duell, Sloan & Pearce, Inc. 420 pp.

Secrets of Industry. By Lewis C. Ord. New York: Emerson Books, Inc. 255 pp. $3.

Public Relations Directory and Yearbook. New York: Public Relations Directory and Yearbook, Inc. 800 pp. $15.

THE ARMY ORDNANCE ASSOCIATION

The Aims and Purposes of the Society

The Army Ordnance Association, a national society of more than 48,000 American citizens, was founded in 1919, "pledged to industrial preparedness for war as our Nation's strongest guaranty of peace." The society was incorporated under the laws of the District of Columbia in 1928. Now that victory has come to our armed forces on land, sea, and in the air, the Association is devoting its entire strength and organization to preparedness. America must be kept strong to meet its national and international obligations. In the words of General Eisenhower, "Only the strong can coöperate; the weak cannot."

During the past twenty-six years the Association has endeavored to keep alive among all our people an interest in and knowledge of the design, production, and maintenance of military armament. This it has done through periods of public lassitude and times of great national emergency. The lessons learned the hard way in World Wars I and II must be perpetuated in order that future generations of Americans may be saved the costly errors and mistakes of our mobilizations when war comes again.

The principal objective of the society is an active membership of American citizens who, familiar with the vital importance of ordnance to our national defense, can assist in making known to industry, science, education, and our public generally the necessity of ordnance preparedness. Basically, the Association endeavors to assist in these fields for the general advancement of scientific design and development of our weapons. Likewise it encourages studies of the procurement, production, maintenance, and supply of our military armament. The Association stands for technical and scientific assistance to our Army, Navy, and Air Forces and for industrial preparedness for our national defense.

The Association is devoted solely to the national defense; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its elected officers and directors serve without remuneration. Membership, to which American male citizens are eligible, is $10.00 for three years or $4.00 for one year. Local chapters of the Association are located throughout the United States.

The objectives of the Association as set forth in its Constitution are:

1. To assist in effecting industrial preparedness for war as being one of the Nation's strongest guaranties of peace;

2. To keep available the highly specialized knowledge necessary for arming the manhood of the Nation by stimulating interest in the design and production of ordnance material;

3. To promote mutual understanding and to effect coöperation with American scientists, inventors, engineers, and manufacturers in civil life, and the Regular and Reserve officers of the Ordnance Department;

4. To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

5. To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

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President: Allen Rushton. Directors: Robert Gregg, T. E. Kilby, Jr., T. W. Martin, W. D. Moore, Lindley Morton, M. E. Pratt, R. J. Stockham, Theodore Swann, Oscar Wells. Treasurer: T. M. Nesbitt, Jr. Secretary: R. E. Parker, 700 Frank Nelson Building, Birmingham, Ala.

Boston, June 30, 1925

President: H. P. Richardson. Vice-Presidents: H. W. Bagnall, F. W. Knauth. Directors: The officers and Henry S. Chafee, D. F. Edwards, R. N. Greenwood, Milton P. Higgins, James L. Martin, C. S. Robinson, J. P. Spang, Jr., W. Stone, George Sweet, Thomas West. Secretary-Treasurer: G. P. Slade, 140 Federal Street, Boston 9, Mass.

Central Illinois, May 29, 1945

President: L. P. Weiner. Vice-President: J. R. Munro. Directors: J. M. Barkman, S. S. Battles, M. C. Budlong, F. E. Martin, Emil Norelius, V. T. Wissen. Treasurer: Merle Yontz. Secretary: Robert Hafer, Peoria Association of Commerce, Peoria, Ill.

Chicago, May 3, 1924

President: T. S. Hammond. Vice-President: John Slezak. Directors: E. J. Bush, W. E. Crocombe, W. H. Damon, Thomas Drever, Henry Isham, James Knowlson, C. A. Liddle, Fowler McCormick, Sterling Morton, F. A. Preston, W. R. Wright. Assistant Treasurer: K. L. Warren. Treasurer: G. D. Dearlove. Assistant Secretary: R. F. Doyle. Secretary: F. W. Renwick, Jr. First National Bank Building, Chicago 3, Ill.

Cincinnati, December 10, 1925

President: Frederick V. Geier. Vice-Presidents: R. G. Calton, Charles W. Dupuis, Louis Schwitzer, Sr. Directors: R. F. Brodie, R. H. Ferger, F. V. Geier, O. S. Hunt, E. A. Muller, Louis Polk, A. H. Pugh, Louis Ruthenburg. Treasurer: C. E. Grubb, Jr. Secretary: J. C. Shouvlin, Big Four Building, Cincinnati, Ohio.

Cleveland, October 25, 1940

President: C. F. Hood. 1st Vice-President: J. C. McHannan. 2nd Vice-President: W. M. Canaday. Directors: R. F. Black, F. H. Chapin, F. C. Crawford, D. S. Ellis, William Forster, B. F. Hopkins, A. D. Joyce, Frank Purnell, H. A. Roemer, G. W. Stephens, W. R. Timken, J. E. Trainer, A. J. Weatherhead, Jr., C. W. Williams, R. J. Wysor. Secretary-Treasurer: E. A. Lynn, 1006 Terminal Tower, Cleveland 13, Ohio.

Empire, April 29, 1938

President: F. J. Smith. Vice-Presidents: E. A. Halbleib, Keith Williams. Directors: G. W. Cole, C. F. Dietz, R. E. Dillon, J. E. Gleason, E. A. Halbleib, C. S. Hallauer, M. J. Hayes, F. F. Hickey, William Kelly, C. H. Lang, T. L. Lee, Earl Norquist, F. J. Smith, D. W. Sowers, Keith Williams. Treasurer: E. R. Davenport. Secretary: F. J. Atwood, 1242 Mercantile Building, Rochester 4, N. Y.

Hartford-Springfield, November 18, 1941

President: F. H. Payne. Vice-Presidents: E. B. Gallaher, C. H. Granger, S. C. Hope. Directors: G. H. Anthony, H. C. Beaver, E. P. Bullard, C. K. Davis, W. M. Goss, D. G. Millar, R. E. Pritchard, Edwin Pugsley, N. F. Ramsey, J. Y. Scott. Secretary-Treasurer: J. S. Begley, 95 State Street, Springfield, Mass.

Lehigh-Bethlehem, November 15, 1939

(Inactive for the duration.)

Lone Star, June 12, 1945

President: D. D. Day. Vice-President: A. J. Armstrong. Directors: E. H. Brooks, G. H. Brown, F. L. Lebus, Charles Medley, F. A. Pierce, H. S. Zane, Jr. Secretary-Treasurer: C. S. Barry, Jr., P. O. Box 2159, Dallas 1, Tex.

LOCAL POSTS OF THE ASSOCIATION

Los Angeles, May 27, 1936

President: Earl B. Gilmore. Vice-President: Donald Douglas. Directors: W. H. Adams, A. R. Baird, F. B. Cole, Ralph O. Cragin, H. S. Hitchcock, M. A. Koffman, M. M. Mitchell, K. T. Norris. Treasurer: Samuel K. Rindge. Acting Secretary: W. B. McGee, 455 Chamber of Commerce Building, Los Angeles 15, Calif.

Massachusetts Institute of Technology, January 20, 1922

(Inactive for the duration.)

Michigan, December 12, 1942

President: E. T. Gusheé. 1st Vice-President: H. F. Harper. 2nd Vice-President: H. L. Pierson. Directors: The officers and H. W. Alden, G. D. Bailey, R. L. Biggers, C. T. Bush, J. M. Dodge, Phil Huber, O. E. Hunt, K. T. Keller, W. F. Rockwell, S. T. Stackpole, Oscar Webber, A. M. Wibel. Secretary-Treasurer: J. W. Paynter, 1243 National Bank Building, Detroit 26, Mich.

Mid-Continent, December 12, 1944

President: Frank Hinderliter. 1st Vice-President: R. R. King. 2nd Vice-President: George Nicholson. Directors: The officers and M. H. Johnson, H. E. McCray, Walter O'Bannon, Jr., W. W. Siegrist, W. H. Stueve, Ed Warmack. Secretary-Treasurer: C. R. Horton, 1308 Hunt Building, Tulsa, Okla.

Midwest, May 16, 1945

President: Harry Darby. 1st Vice-President: J. C. Shepherd. 2nd Vice-President: C. M. Standiford. Directors: L. M. Alexander, P. A. Froeschl, F. B. Nichols, P. F. Rahm, R. M. Williams, E. J. Ziegler. Secretary-Treasurer: P. L. Kerns, 918 Porter Building, Kansas City 2, Mo.

Milwaukee, September 26, 1928

President: W. W. Coleman. Vice-President: J. E. DeLong. Directors: F. R. Bacon, Harold Falk, Walter Geist, H. S. Johnson, Jr., H. V. Kohler, P. J. E. Wood. Secretary-Treasurer: F. O. Wyse, Bucyrus-Erie Company, So. Milwaukee, Wis.

Nebraska, June 22, 1944

President: Karl E. Vogel. Vice-President: Charles D. Ammon. Directors: Dana C. Bradford, H. L. Dempster, Ben Hughes, C. L. Kirkland, John L. McCague, C. T. Spier. Secretary-Treasurer: Fred G. Arkoosh, 109 S. 10th Street, Omaha, Nebr.

New York, June 15, 1921

President: R. E. Gillmor. 1st Vice-President: H. M. Tillinghast. 2nd Vice-President: J. E. McNary. 3rd Vice-President: T. E. Murray. 4th Vice-President: J. T. Mackey. Executive Committee: The officers and T. F. Brown, W. A. Davidson, W. C. Dickerman, C. J. Hardy, C. W. Keuffel, A. E. Van Cleve. Treasurer: C. Stewart Comeaux. Secretary: Stewart E. Reimel, 80 Broadway, New York, N. Y.

New York University, April 16, 1943

President: T. R. Torian. Vice-President: Elliot Schick. Treasurer: R. F. Borg. Secretary: Stanford Schwartz, Department of Industrial Engineering, New York University, New York, N. Y.

Northwest, March 15, 1945

President: L. S. Oakes. Vice-Presidents: H. A. Bullis, W. G. Seeger. Directors: The officers and C. E. Buckbee, R. P. Carlton, A. D. Chisholm, C. L. Horn, W. F. Kasper, W. C. MacFarlane, A. V. Stallard, H. W. Sweatt, A. M. Wilson, F. B. Winston, Brison Wood. Secretary-Treasurer: R. F. Wilson, Palace Building, Minneapolis 1, Minn.

Philadelphia, December 9, 1926

President: C. Jared Ingersoll. Vice-Presidents: William D. Disston, George W. Elliott. Directors: E. G. Budd, D. K. Bullens, R. A. Cannon, W. D. Disston, G. W. Elliott, L. E. Hess, Ralph Kelly, E. T. Longstreth, R. P. Page, Jr., W. F. Perkins, H. W. Prentis, Jr., W. Wear, C. M. Woolworth. Secretary-Treasurer: C. W. Sorber, 150 S. Broad Street, Philadelphia 2, Pa.

Pittsburgh, February 24, 1927

President: J. D. Berg. Vice-Presidents: R. C. Downie, T. E. Millsop. Directors: The officers and F. B. Bell, H. A. Gidney, J. K. B. Hare, H. E. Lewis, J. L. Perry, A. E. Walker. Treasurer: T. H. Eddy. Secretary: W. S. Rial, Jr., 1202 Chamber of Commerce Building, Pittsburgh 19, Pa.

Puget Sound, January 25, 1944

President: A. F. Parker. 1st Vice-President: F. B. Lee. 2nd Vice-President: John Nagel. Directors: George Comstock, C. R. Currier, Roger Cutting, J. A. Denn, Adolph Engstrom, Watt Fallis, A. Finlayson, Henry Isaacson, George Lamb, M. D. Mills, Paul Pigott, Walter Toly. Secretary-Treasurer: C. W. Huffine, 517 Arctic Building, Seattle 4, Wash.

Quad Cities-Iowa, May 28, 1945

President: C. D. Wiman. Vice-President: J. C. VanderPyl. Directors: F. H. Anderson, N. L. Etten, J. E. Kanaley, H. K. Kicherer, E. J. Lattner, H. S. Lord, E. W. Ross, C. R. Sheaffer, E. M. Shinkle, H. V. Sivright, T. E. Stahl, C. A. Waldmann. Secretary-Treasurer: W. B. Walker, Rock Island Arsenal, Rock Island, Ill.

Red River, July 12, 1941

President: R. S. F. DeMent. 1st Vice-President: M. G. D. Prentice. 2nd Vice-President: W. J. Boyd. Counsel: J. M. Murphy. Directors: The officers and R. N. Bodine, J. P. Fuzy, H. T. Dulin, C. E. Williams. Treasurer: E. L. Emmons. Secretary: C. F. Olson, Red River Ordnance Depot, Texarkana, Tex.

Rocky Mountain, June 10, 1942

President: Henry A. Winter. Directors: F. R. Eberhardt, B. C. Essig, J. K. Garretson, J. G. Gates, W. R. Heckethorn, J. D. Maitland, N. H. Orr, R. S. Payne, W. C. Redfield. Secretary-Treasurer: James Colasanti, 601 Continental Oil Building, Denver, Colo.

St. Louis, January 18, 1927

President: Edwin B. Meissner. Vice-President: Clyde H. Morgan. Directors: W. M. Akin, Ben Comfort, H. B. Deal, R. E. Gardner, Jr., Spencer Olin, Harry Scullin, W. S. Symington, P. J. Watson, Jr. Secretary-Treasurer: M. F. Hubbell, 3663 Lindell Boulevard, St. Louis, Mo.

San Francisco, October 17, 1923

President: R. C. Force. Vice-Presidents: Charles Kendrick, C. E. Moore. Directors: William Cavalier, Ralph Elsman, R. C. Force, Ernest Ingold, Samuel Kahn, Charles Kendrick, C. E. Moore, Roland L. Oliver, G. G. Pollock, Carl F. Wente, C. S. Wheeler, Jr., Dean Witter. Secretary-Treasurer: Ivor De Kirby, P. O. Box 567, 100 McAllister Street, San Francisco 1, Calif.

Texas, October 30, 1942

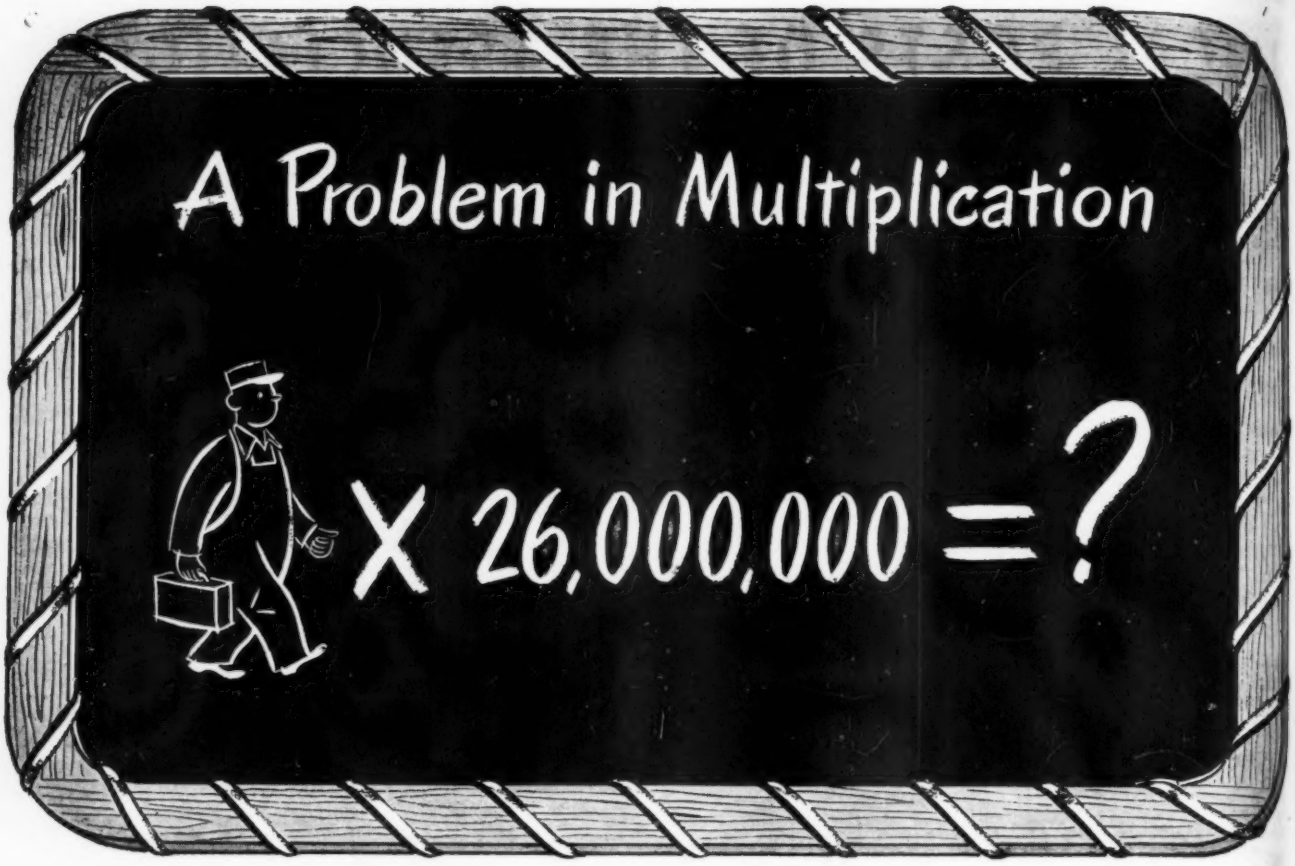
President: W. R. England. Directors: C. C. Chambers, J. M. Kinkaid, B. T. McNeil, C. E. McRae, M. J. Neeley, Harry Sinclair. Secretary-Treasurer: G. I. Calvert, 1717 Neils-Esperson Building, Houston 2, Tex.

University of Michigan, February 20, 1941

(Inactive for the duration.)

Washington, November 18, 1925

President: G. M. Barnes. Vice-Presidents: Donald Armstrong, H. P. Erwin. Directors: Arthur Adelman, A. F. E. Horn, Earl McFarland, F. A. McMahon, Chester Smith, F. E. Wright. Secretary-Treasurer: W. G. Donald, 705 Mills Building, Washington 6, D. C.



Take the case of John Smith, average American:

For over three years now, he's been buying War Bonds through the Payroll Savings Plan. He's been putting away a good chunk of his earnings regularly—week in, week out. Forgetting about it.

He's accumulating money—maybe for the first time in his life. He's building up a reserve. He's taking advantage of higher wages to put himself in a solid financial position.

Now suppose *everybody* in the Payroll Plan—everybody who's earning more than he or she needs to live on—does what John Smith is doing. In other words, suppose you multiply John Smith by 26 million.

What do you get?

Why—you get a whole country that's just like John Smith! A solid, strong, healthy, prosperous America where everybody can work and earn and live in peace and comfort when this war is done.

For a country *can't help* being, as a whole, just what its people are individually!

If enough John Smiths are sound—their country's *got* to be!

The kind of future that America will have—that you and your family will have—is in your hands.

Right now, you have a grip on a *wonderful* future. Don't let loose of it for a second.

Hang onto your War Bonds!

BUY ALL THE BONDS YOU CAN...
KEEP ALL THE BONDS YOU BUY

THE ARMY ORDNANCE ASSOCIATION

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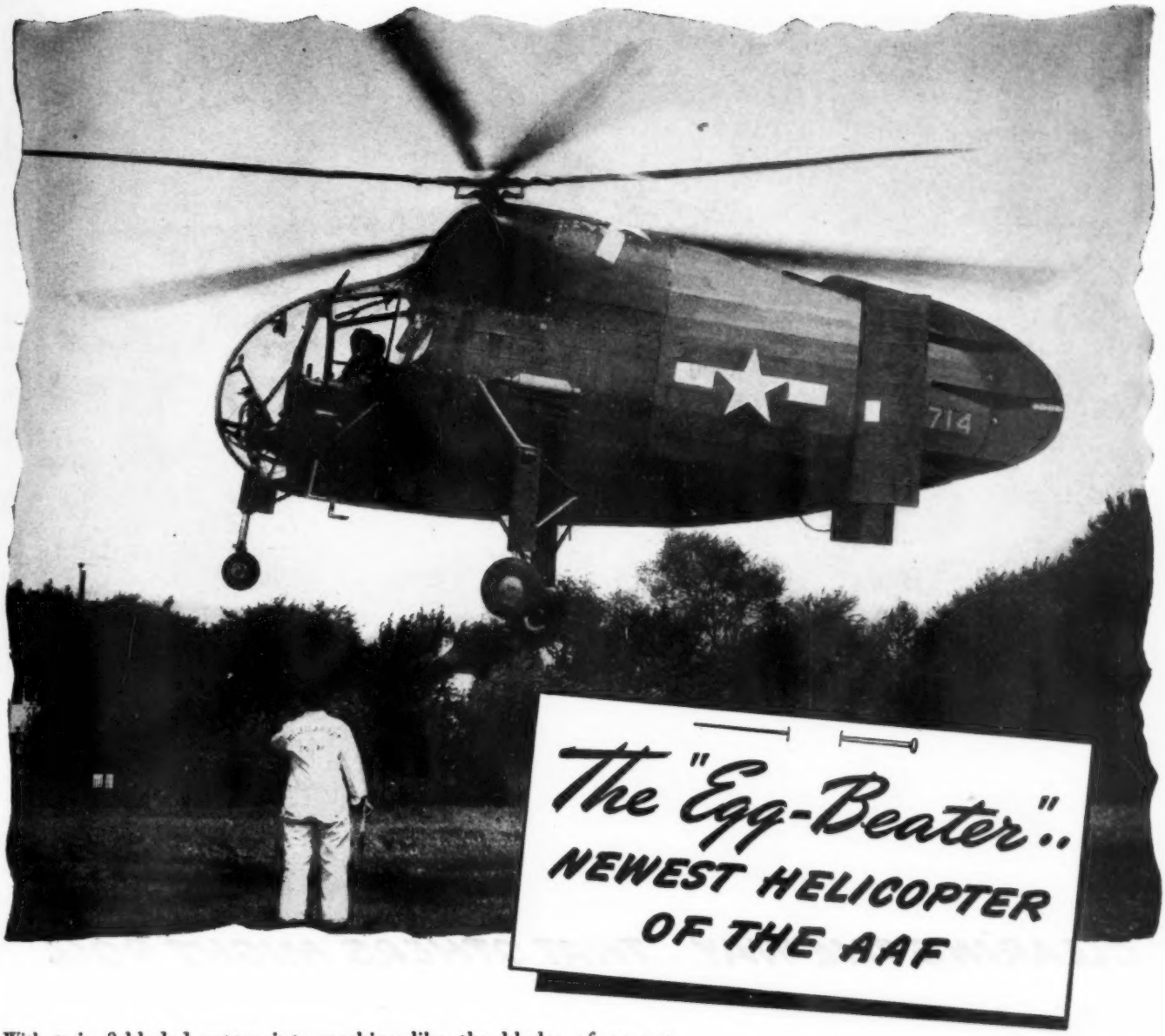
ARMY ORDNANCE, November-December 1945. Vol. XXIX, No. 153. Published bimonthly. Editorial and publication offices, The Mills Building, Pennsylvania Ave. at 17th St., N.W., Washington 6, D.C. 75 cents a copy. $4.50 a year. Unsolicited manuscripts should be accompanied by return postage. Entered as second-class matter August 14, 1920. at the Post Office, Washington, D.C., under the Act of March 3, 1879. Additional second-class entry at the Post Office at Richmond, Va. Printed in the U.S.A. by the William Byrd Press, Inc., Richmond, Va. Copyright 1945 by the Army Ordnance Association. All rights including translation into other languages reserved by the publisher in United States, Great Britain, Mexico, and all countries participating in the International Copyright Convention and the Pan-American Copyright Convention.



The "Egg-Beater".. NEWEST HELICOPTER OF THE AAF

With twin 3-bladed rotors intermeshing like the blades of an egg beater, the Kellett XR-8 presents a new and novel design in helicopters. A purely experimental model built for the Army Air Forces, the XR-8 has the advantages of greater power efficiency, reduction of vibration, reduced drag, and reduced power transmission requirements.

Reports from test pilots indicate that it is highly maneuverable, and since the rotors revolve in opposite directions, there is no need for a tail rotor to counteract torque. While no performance figures have been released, the ship is powered by a Franklin air-cooled 245 h.p. engine using CECO fuel pumps.

Chandler-Evans is proud to have a small part in this new step in helicopter development. And as Chandler-Evans has always kept abreast of the newest and latest in America's other great war planes, so will it continue to serve the aviation industry when once again it turns to peacetime production.

The Kellett XR-8 has all the remarkable helicopter characteristics of vertical rise and descent, ability to hover, and to fly backwards and sidewise as well as forwards. (Kellett Aircraft photo).

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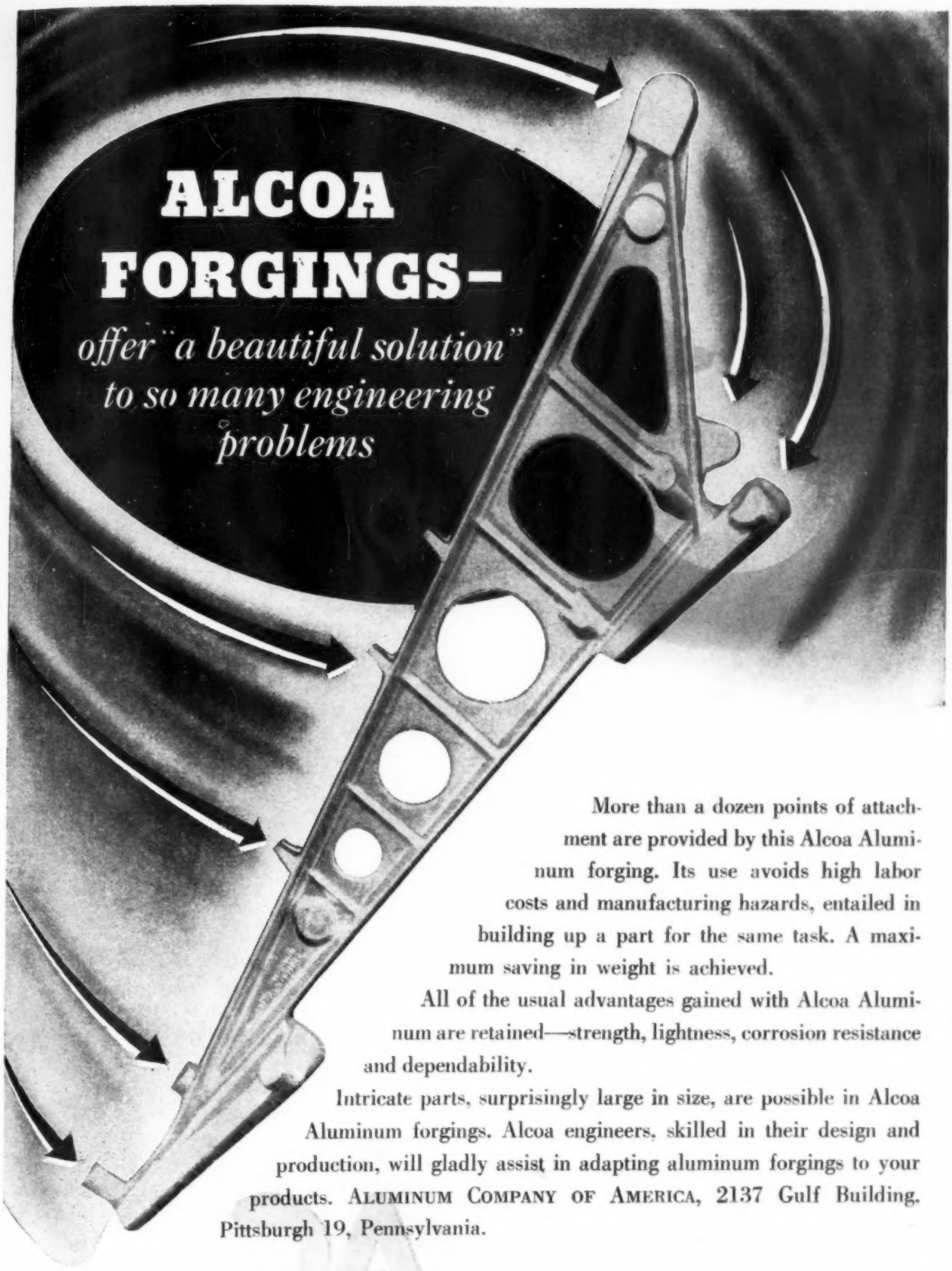
IT IS SIGNIFICANT THAT AMERICA'S FINEST MOTOR TRUCK FLEETS ARE EQUIPPED WITH BENDIX-WESTINGHOUSE AIR BRAKES



More than a dozen points of attachment are provided by this Alcoa Aluminum forging. Its use avoids high labor costs and manufacturing hazards, entailed in building up a part for the same task. A maximum saving in weight is achieved.

All of the usual advantages gained with Alcoa Aluminum are retained—strength, lightness, corrosion resistance and dependability.

Intricate parts, surprisingly large in size, are possible in Alcoa Aluminum forgings. Alcoa engineers, skilled in their design and production, will gladly assist in adapting aluminum forgings to your products. ALUMINUM COMPANY OF AMERICA, 2137 Gulf Building, Pittsburgh 19, Pennsylvania.

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Too Much, Too Soon

(for the Axis)

Cooperating with Ordnance officials, AC was producing Browning machine guns many months before America entered the war. Other war products followed in rapid succession until, by the time Germany surrendered, AC had built 459 *kinds* of war supplies for Allied armed services. Plant after plant was added, the payroll mounted to more than 19,000 men and women, the output totaled many millions of units.

That's the history of just one of thousands of American factory organizations, whose amazing productivity overcame years of Axis preparation and helped the Army and Navy to change "too little, too late" to "too much, too soon" (for the Axis).

AC SPARK PLUG DIVISION

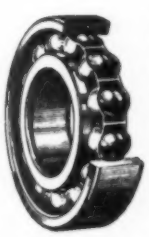
GENERAL MOTORS CORPORATION

BUT **Hiroshima, where millions of ball bearings were stock-piled, was target for the first atomic bomb in history.**

AND **Schweinfurt and the other Nazi ball bearing centers were primary objectives of our bombers in Europe.**

Yes, the heart of *any* nation's industrial might is the ball bearing.

Nothing rolls like a ball. It is nature's favorite, strongest form. Thus, the *ball* bearing is a "natural" for the higher speeds, heavier loads and greater rigidity demanded by today's exacting production standards.



When designing your new machines, take advantage of the creative engineering, technical skill, long experience and precision manufacturing methods of New Departure—the world's greatest maker of ball bearings.

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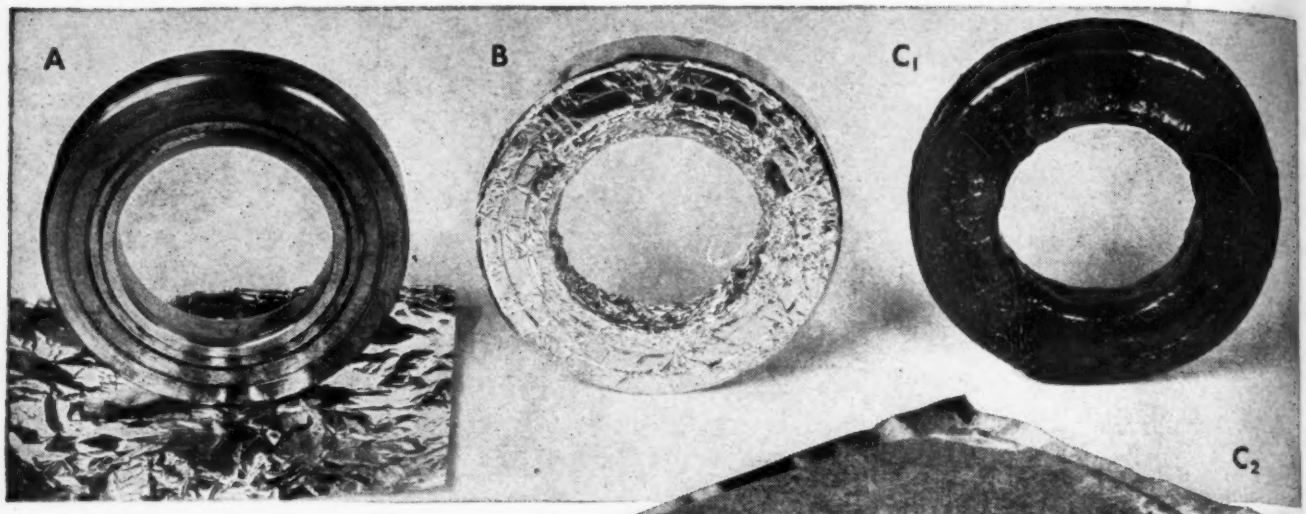

NEW...

a CORROSION-PROOF method for wrapping metal parts with REYNOLDS ALUMINUM FOIL

THE NEW METHOD of wrapping bearings: After cleaning and preserving, bearing is placed upright on a *single* sheet of Reynolds Foil (Fig. A.) The bearing is then doughnut wrapped and the foil pressed firmly and smoothly to the bearing to take advantage of Cathodic Protection (Fig. B). Wrapped bearing is then: (1) plastic dipped (Fig. C1). OR (2) placed in approved Reynolds bag and heat sealed. (Fig. C2).

ALUMINUM FOIL, specially processed by Reynolds, offers three distinct advantages in packaging Metal Parts:

1. **Acts as a positive barrier against moisture vapor transmission.**
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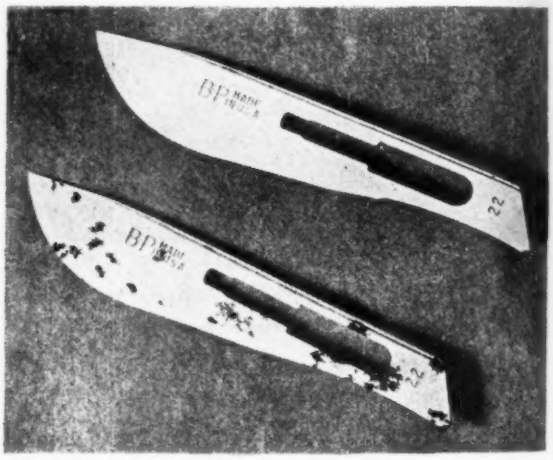
3. **Gives extra economies in material and man hours.**

It all came out some months ago, when the Army Medical Corps, in co-operation with Reynolds, completed tests in wrapping surgical instruments in Aluminum Foil. The results were so successful that the Medical Corps specified Aluminum Foil for this new method of packaging, which combines a moisture-barrier with "Cathodic Protection." (See photo of test shown on this page).

Now, experiments with other branches of the Service, and with prominent manufacturers, have revealed some revolutionary developments in parts packaging. This new method has countless applications in all branches of the Services and after the war will be important in packaging of many civilian products.

If you would like to have a reprint of a recent authoritative article on Cathodic Protection, as well as complete data on the new uses of Aluminum Foil in packaging metal parts, write Reynolds Metals Company, Richmond 19, Virginia.



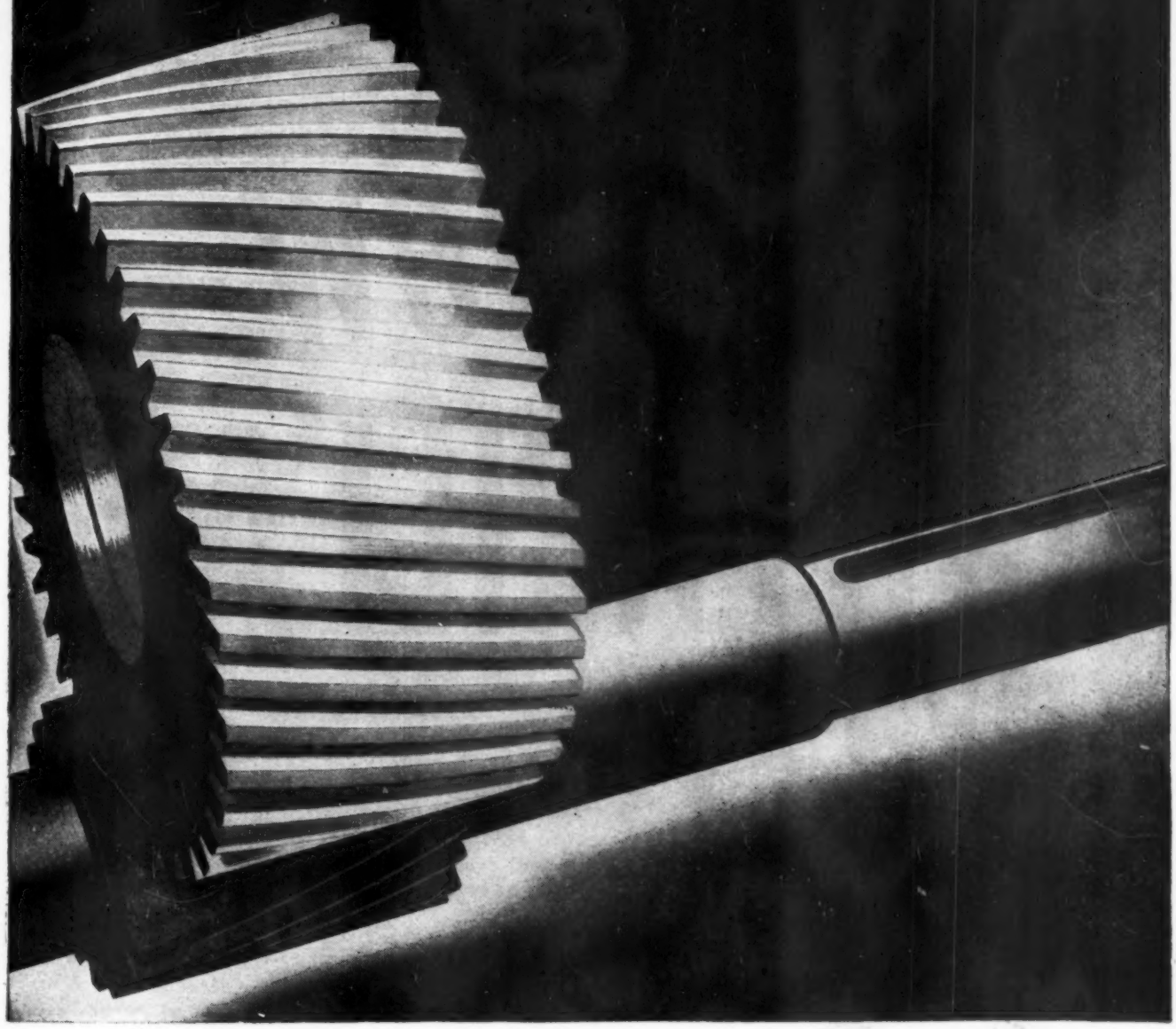
SURGICAL BLADES used in Army Medical Corps experiment. Blade above wrapped in foil—below in neutral paper. These are the results after 11 days at 122° F., 95% relative humidity. In both cases, blade was cleaned and preserved before wrapping.

REYNOLDS METALS

REYNOLDS METALS COMPANY

Leads the way in Foil Packaging

Molybdenum gives steel the strength and toughness necessary to make long-lived gears.



CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

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Your "Caterpillar" dealer will gladly give you full information on these rugged earthmovers. Better still, he will help you get them at the earliest possible date. Now, more than ever before, he is a good man to know. See him soon.

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- LONG CABLE LIFE
- SAFE OPERATION
- FINE VISIBILITY
- HIGH LIFT
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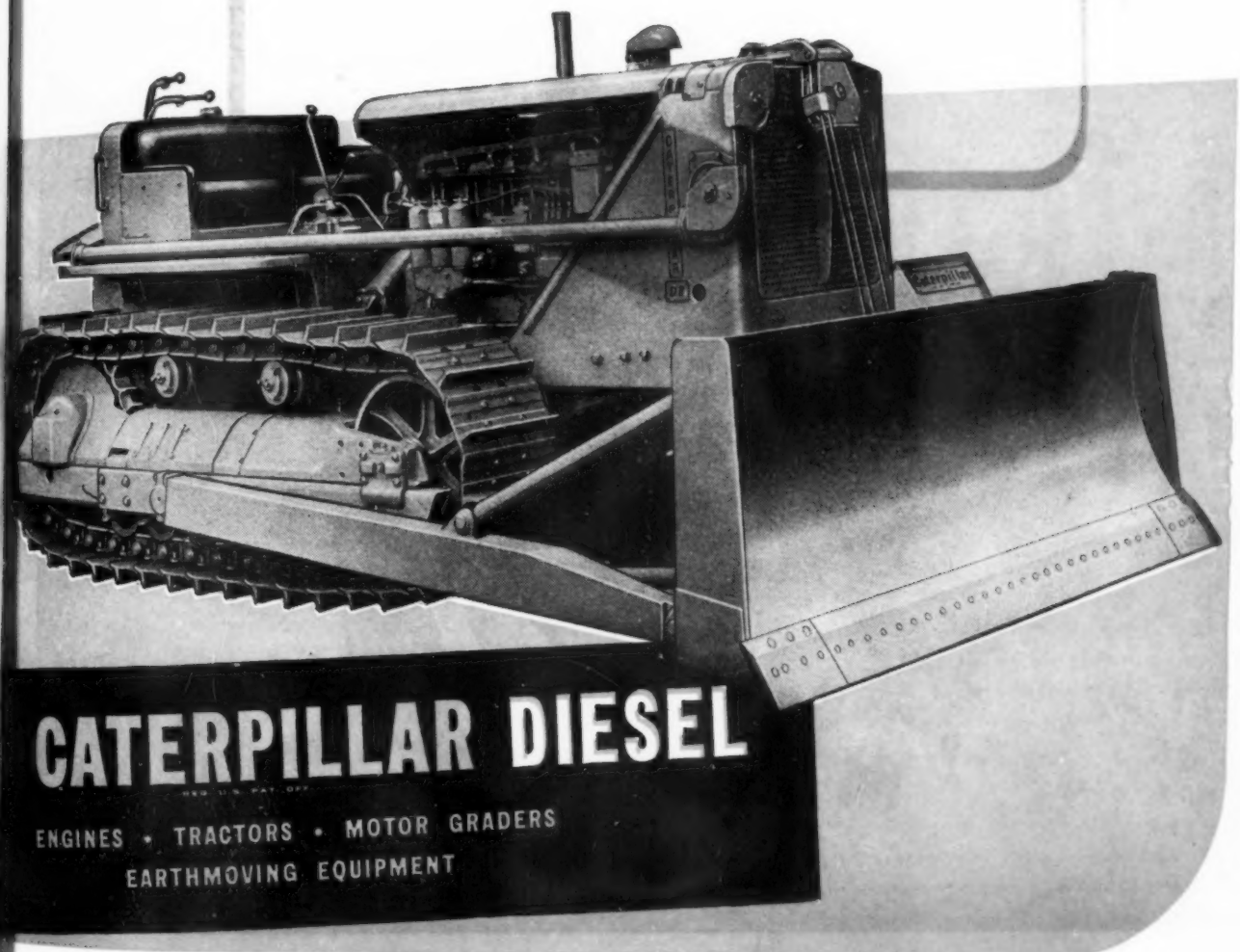

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THE GREYHOUND OF TOMORROW!

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• The job is finished. Now a new job is here—winning and keeping the peace.

And no small item in the winning of the peace will be all mankind's memory of what U. S. Army Ordnance can do. It's a "big stick" that will make would-be aggressors pause, and be good boys.

It has been a privilege for all of us here at Stewart-Warner to have played a part in the achievements of American arms. And, as we turn our energies, skills and facilities to producing for a peaceful America, we raise our voices in one last salute to Army Ordnance. Do you hear it? It's a hearty and grateful "Well Done" from every Stewart-Warner worker.

ARMY E NAVY

STEWART-WARNER CORPORATION

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EASY TO INSTALL . . . TO SERVICE

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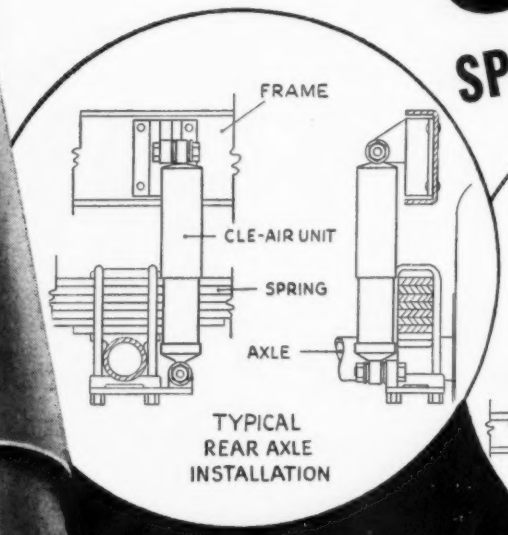
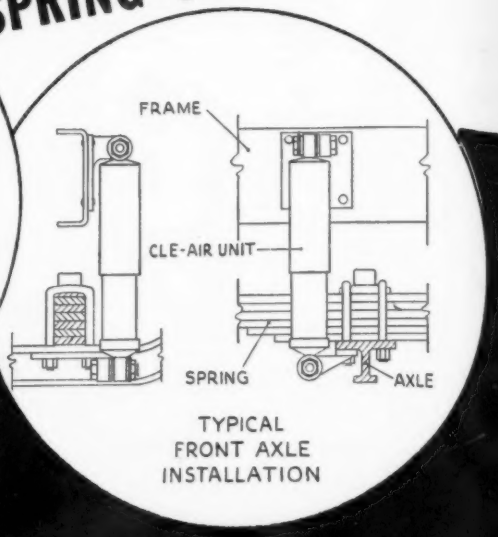
CLE-AIR SPRING CONTROL UNITS



TYPICAL REAR AXLE INSTALLATION

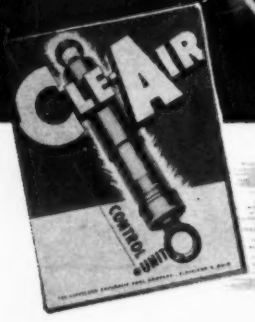


TYPICAL FRONT AXLE INSTALLATION

CLE-AIR UNITS

OTHER **CLE-AIR** FEATURES

1. EXCLUSIVE DUAL ACTION — BOTH HYDRAULIC AND PNEUMATIC
2. PRECISION CONSTRUCTION TO AIRCRAFT TOLERANCES
3. SUITABLE FOR ALL TYPES OF BUSES, TRUCKS AND TRAILERS
4. PROTECT BODIES, SPRINGS, TIRES AND FRAMES FROM ROAD SHOCK
5. BACKED BY OVER FIFTY YEARS MANUFACTURING EXPERIENCE



NEW BOOKLET contains all the facts on Cle-Air Units. Write for your copy now.

THE CLEVELAND PNEUMATIC TOOL CO.

AUTOMOTIVE DIVISION

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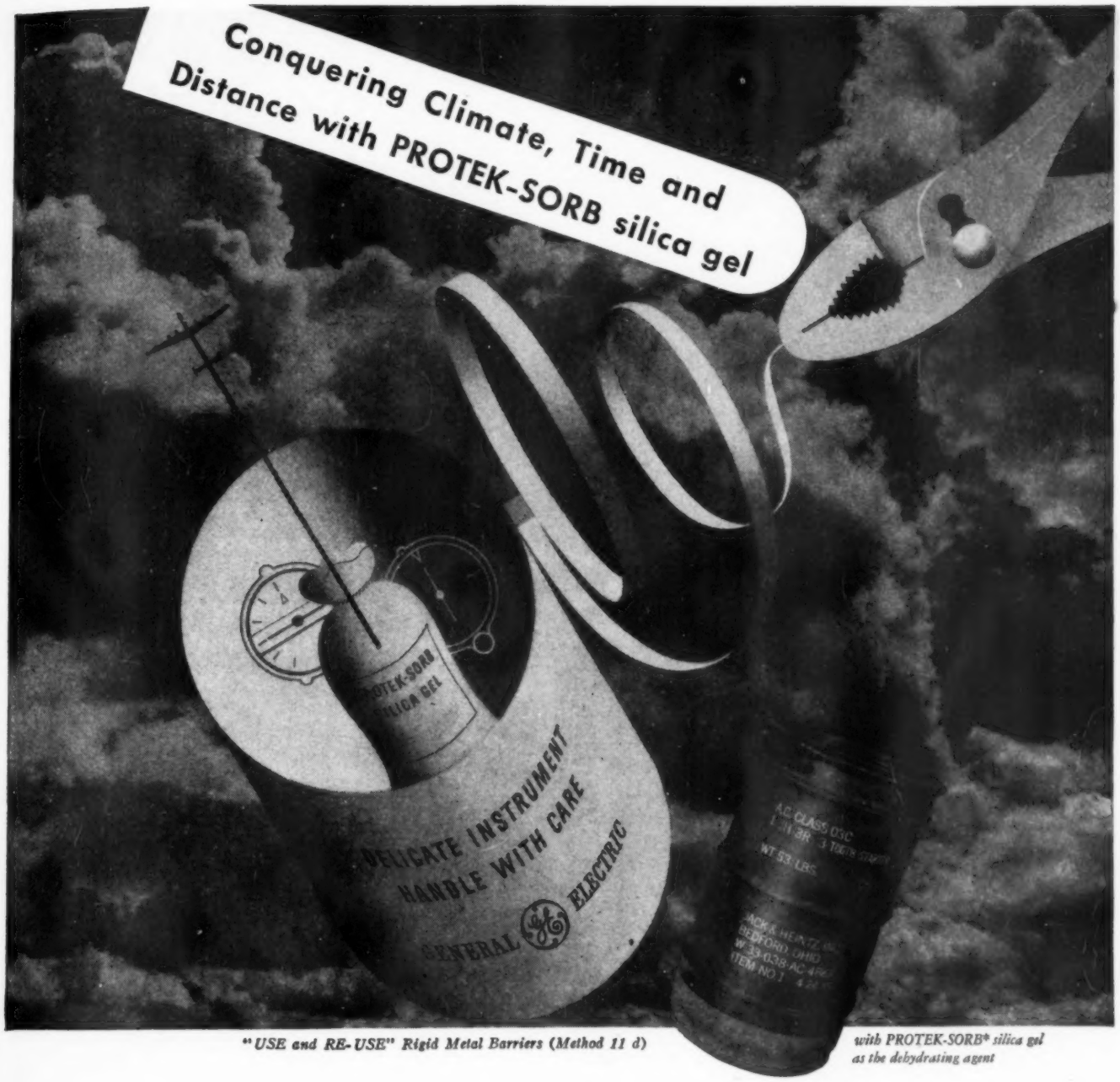
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with PROTEK-SORB silica gel as the dehydrating agent*

PROTEK-SORB assures your product reaching consumers in any climate factory-fresh, ready for immediate use without cleaning and tampering with adjustments.

Your product is judged by what the consumer receives. Research, care in design and manufacture, all are of no avail if rust, corrosion, mildew and mold take their toll while your goods are in transit and storage.

Rigid metal moisture barriers, with Protek-Sorb silica gel, have proved their efficiency and economy in the armed forces. They can be *used* and *re-used*—with activated Protek-Sorb in shipping new material . . . in making returns to factory for repairs . . . in storing rebuilt assemblies. Consult Davison packaging engineers regarding your present and post-war problems wherever moisture damage is a hazard.

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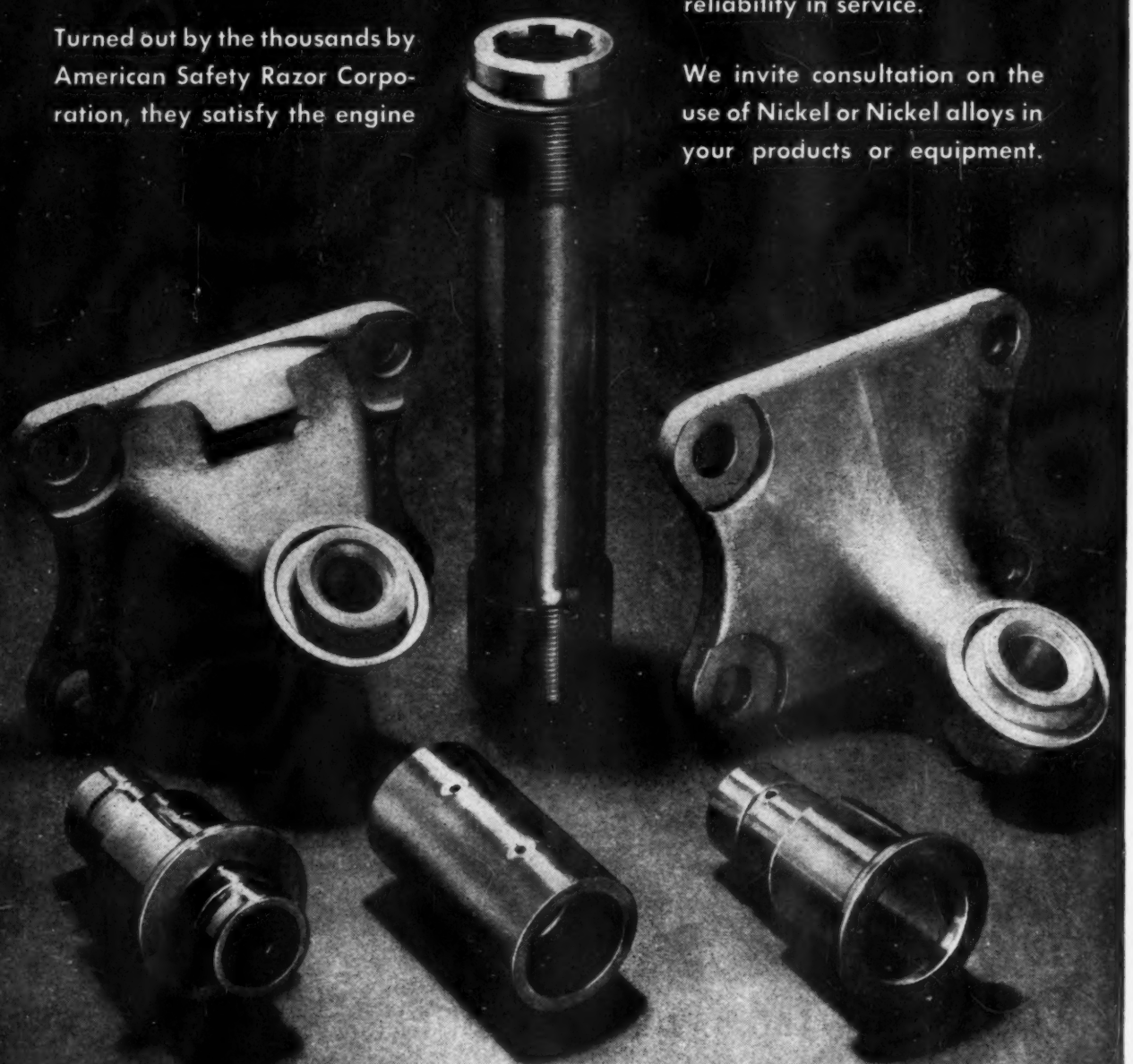
Provide Essential Dependability

These Nickel steel parts for aircraft engines meet the rigid requirements and specifications of the Army Air Forces.

Turned out by the thousands by American Safety Razor Corporation, they satisfy the engine builders' demands for high mechanical properties, minimum distortion after heat treatment, close tolerances and thorough reliability in service.

We invite consultation on the use of Nickel or Nickel alloys in your products or equipment.



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Cut operating costs

EXTRA HEAVY INSULATORS

Thermal conductivity greater than in ordinary insulators — allows a longer firing tip for any heat range plug.

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Gives greater gap life than ordinary electrodes.

WIDE HEAT RANGE

Meets a broader variety of driving conditions.

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For truck, tractor, bus, and other heavy duty operations, Auto-Lite heavy duty spark plugs will more than pay for themselves. Carefully kept records have proven the value of plugs built especially for the job. See for yourself how you can help assure top efficiency by installing Auto-Lite heavy duty spark plugs.

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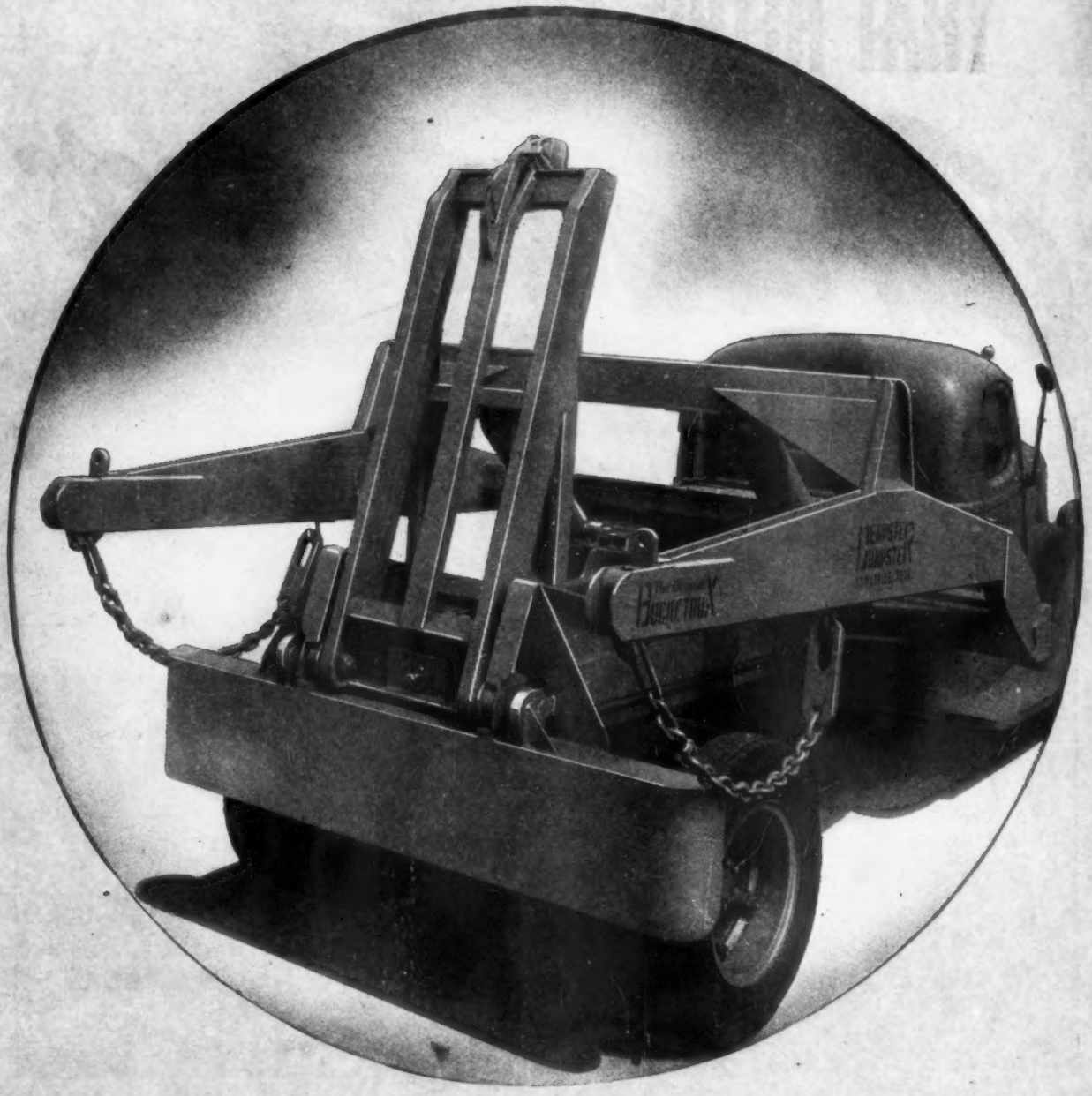
It's Simple... It's Sure...

—CUTTING COSTS OF MATERIALS HANDLING THE DEMPSTER-DUMPSTER WAY!

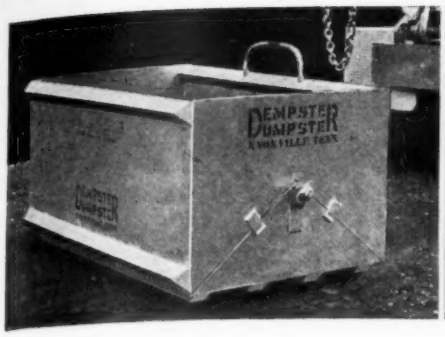


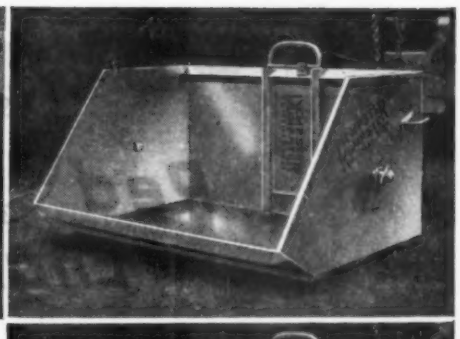
★ Cutting costs of materials handling with the Dempster-Dumpster system is recognized very quickly by those already using conventional trucks. But, in hundreds of plants where materials handling systems are in use where trucks are not now required, the possibilities of the Dempster-Dumpster and its tremendous savings are often overlooked.

The Dempster-Dumpster is not an ordinary materials-handling-by-truck operation. The Dempster-Dumpster is a unit—made in several types and sizes—mountable on any truck chassis, for hoisting, placing in carrying position, and dumping any one of dozens of different types of Dempster-Dumpster bodies for handling every conceivable character of material. When installed on your truck chassis, this one unit will serve any number of bodies your operation may require. Some plants are using a single Dempster-Dumpster unit to serve 50 to 75 bodies. In certain cases several types of bodies, for various types of materials, are used, and all served by a single Dempster-Dumpster.

DEMPSTER DUMPSTER

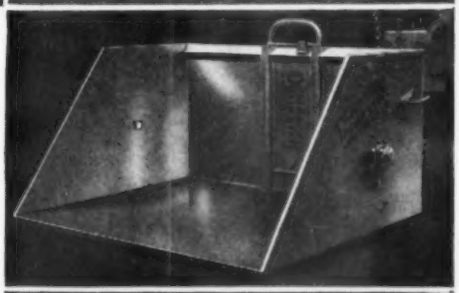
TRADE MARK REG.

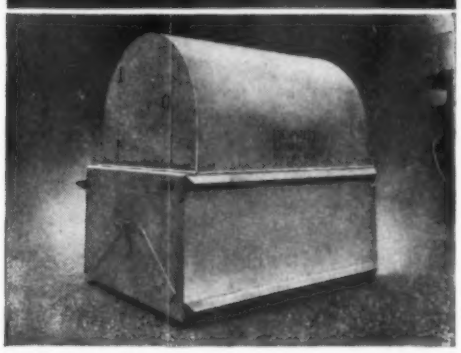




DEMPSTER DUMPSTER REGULAR BODIES

★ Shown above and at right, photos 1 through 5 inclusive, are five of our "regular" Dempster-Dumpster bodies. These are basic designs from which hundreds of variations, so-called "special" designs, are produced to meet the particular requirements of any materials handling problem. These "regular" bodies, in order, are: 1—Bottom dumping, 2—Tilt-type, 3—Skip-type with lip, 4—Skip-type flat bottom and, 5—Apartment-type for bulky materials, trash, or rubbish. These bodies are built in from 1½ to 10 cu. yd. sizes or 1½ to 7½ tons pay load capacities.

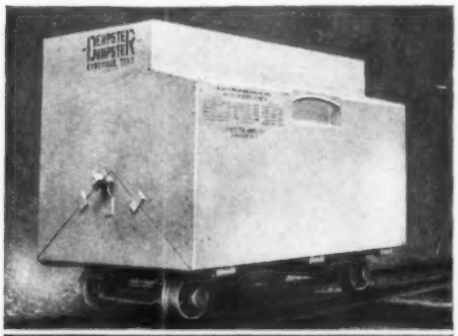


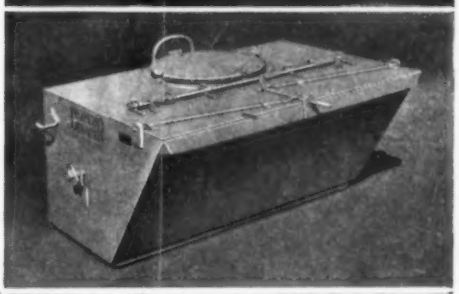


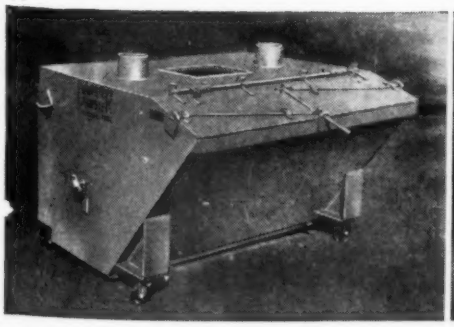
DEMPSTER DUMPSTER "SPECIAL" BODIES

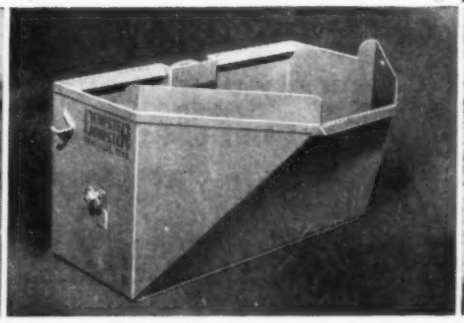
★ Shown in photos 6 through 10 inclusive are five examples of "special" bodies, now serving some of the nation's largest industrial plants. Note in No. 6 that precision bearing, flanged car wheels have been adapted to a bottom dumping body. Wheels remain on body when picked up by Dempster-Dumpster for further transportation and dumping. Photo No. 7 shows a Tilt-type body developed for handling a semi-liquid material. No. 8 for handling dust collection. No. 9 for moulding sand. No. 10 for a finely ground material and having swivel casters for easy maneuverability in plant. Hot materials up to 1700° F are being handled by the Dempster-Dumpster, finished and unfinished products, light, heavy and liquid materials as well.

If you have any idea the Dempster-Dumpster may be adapted to your use to advantage, our engineers will gladly go over the matter with you. Write for our new Catalog No. 245 now. Dempster Brothers, Inc., Knoxville 17, Tennessee, U. S. A.

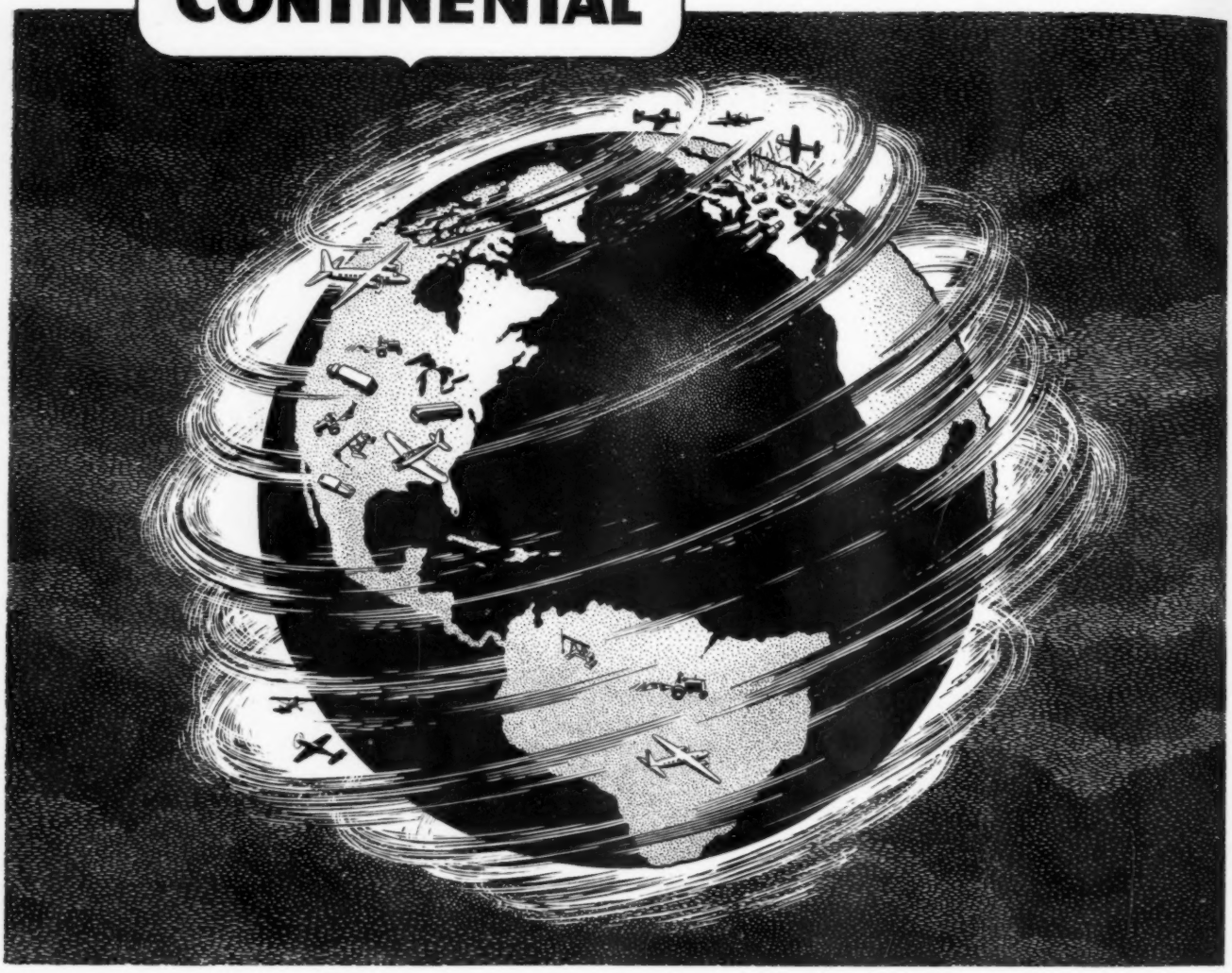








POWER BY Red Seal Engines CONTINENTAL



Continental will always remain proud of its record as one of the "great engine builders" of the War. But with that task successfully completed, Continental looks forward with even greater anticipation to being one of the world's prime sources of peacetime power.

The number and diversity of peacetime engine commitments already on Continental's books promises much for the prosperous on-going of our national economy.

Continental Motors Corporation

MUSKEGON, MICHIGAN

There's a Du Pont Molten Salt Bath for Any Type of Case Hardening

Case Depth Desired	Recommended Bath	Temp. °F	NaCN %	STARTING COMPOSITION	REPLENISHING COMPOSITION
0.003" to 0.010"	PLAIN CYANIDE	1400 to 1600	20-30	30 or 45% CYANIDE-CHLORIDE MIXTURE, "CYANEGG" and NaCl, and/or Na_2CO_3	45, 75 or 96% NaCN—depending on dragout loss
0.010" to 0.035"	DU PONT ACCELERATED SALT with Graphite Cover	1500 to 1650	18-22	ACCELERATED SALT or ⅕ HEAT TREATING SALT No. 6 plus ⅘ ACCELERATED SALT	ACCELERATED SALT
0.025" to 0.090"	DU PONT CARBURIZING SALT with Graphite Cover	1650 to 1750	8-12	⅕ CARBURIZING SALT plus ⅘ HEAT TREATING SALT No. 6	CARBURIZING SALT

EACH OF THESE BATHS is designed to produce cases of desired depth in the shortest possible time at the lowest possible cost. Yet they're but three of many Du Pont heat treating products that will return top production for you with maximum economy. Du Pont technical men will work with you in selecting the right materials to meet specific needs. For further details write: E. I. du Pont de Nemours & Co. (Inc.), Electrochemicals Department, Wilmington 98, Delaware.

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REG. U. S. PAT. OFF.

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DU PONT CYANIDES and SALTS *for Steel Treating*

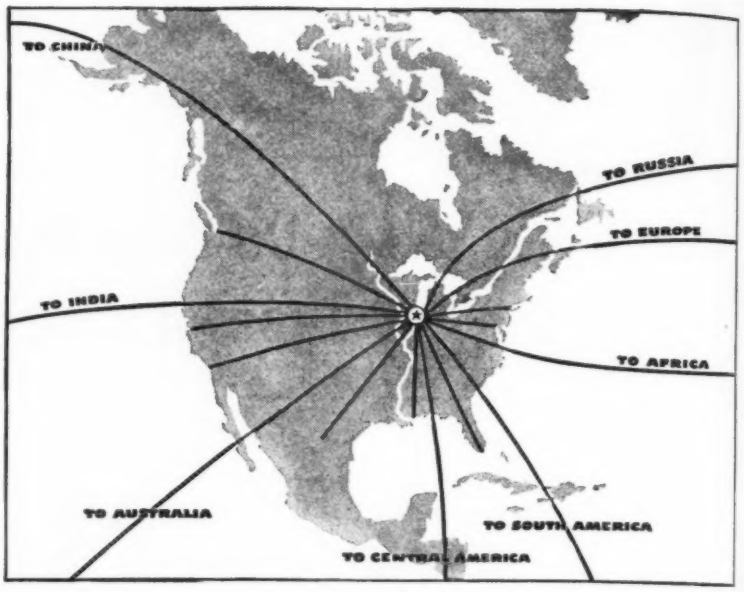
Chicago and Northern Illinois

center of U. S. Population

center of World Airways

railroad center of U. S.

the "Great Central Market"



Industries locating in this area have these outstanding advantages—

Railroad Center of the United States . . . Served by 22 trunk line and 17 belt, terminal and industrial railroads —within overnight reach of 50,000,000 consumers.

The "Great Central Market". . . Retail and wholesale trade of more than eight billion dollars annually.

Financial Center . . . More than eight billion dollars of financial assets available to business.

Adequate Postwar Labor Supply . . . Skilled and unskilled, for diversified industry and construction—best record for good labor relations.

2,500,000 Kilowatts of Power . . . Plentiful supply for industry, home and farm.

Abundant Gas and Oil . . . Large-volume pipelines direct from country's greatest sources.

Great Inland Port . . . The harbors of the Chicago area normally handle more water-borne traffic each year than does the Panama Canal.

Great Food Producing and Processing Center . . . In the heart of the nation's richest agricultural lands.

Leader in Iron and Steel Manufacturing . . . Chicago Industrial Area ranks high in the manufacture of iron and steel products.

Tremendous Coal Reserves . . . Short haul from great central bituminous fields.

World Airport . . . For national and international air transport.

Geographical Center of U. S. Population . . . Has gradually moved westward—now located within this area.

Good Government . . . Complete and efficient community services.

Good Living . . . Fine home communities, shopping centers, recreation facilities, schools, colleges, hospitals and churches.

These are some of the advantages that make Chicago and Northern Illinois pre-eminent in the industrial future of the United States—the first consideration in a choice of industrial re-location. As an aid to business, agriculture and industry, wherever located, we have established a department to assemble and make available factual data concerning this area.

In carrying forward this work, we will cooperate fully with all other agencies interested in the progress of Chicago and Northern Illinois. You are invited to make use of the services of this department. Communicate with the TERRITORIAL INFORMATION DEPARTMENT, *Marquette Bldg., 140 South Dearborn St., Chicago 3, Ill.—Telephone Randolph 1617.*

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THE *BIG FOUR*

OF AMERICAN NATIONAL DEFENSE

Publications of the Army Ordnance Association, now being read by nearly 50,000 members and subscribers, are recognized as the "Big Four" of national defense. Here they are:

1

Army Ordnance, a bimonthly journal of industrial preparedness, founded 1920, acknowledged the world over for its authentic, timely, and thought-provoking discussions of industrial preparedness, Ordnance research, and all questions connected with the national defense of the United States. It is highly illustrated.

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Army Ordnance Bulletin, a monthly newsletter from Washington, founded 1940. This little letter has top popularity among members of the A.O.A. Its analyses of current national-defense happenings not only record what has taken place but frequently give a fair indication of what may happen. It's frank, free, and fearless.

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4

Logistics, to keep America strong ashore, afloat, and aloft, founded 1945. It brings together in one forum views, principles, and ideas from all fields of our national defense. This new magazine is dedicated to the proposition that America must be kept strong. It will serve as a medium for the effective utilization of our national resources for peace and security.

● If you want to keep abreast of national defense developments in the trying years ahead, don't miss these privileges of membership in the A.O.A. An application is on the next page. Pass it along to a friend or present him with a membership for Christmas.

APPLICATION FOR MEMBERSHIP

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(Print plainly)

Address.....
(Street and Number)

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I am a citizen of.....

Race.....

Born at..... Date.....

Educated at.....

Courses.....

Present civil position.....

Previous civil experience.....

.....

Military or naval service (if any).....

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If not now in service, was discharge honorable?.....

Present military or naval status.....

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References (not necessarily members of the Association).....

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Date.....

Signature.....

(Do not write below this line)

Application received.....

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U.S. NAVY
adopts
SIGNAL (DISTRESS DAY AND NIGHT)
MARK 13 MOD O

Patent Applied For

BY DAY . . . a dense cloud of
High Visibility Orange Smoke

AT NIGHT . . . a brilliant
20,000 Candle-Power Red Flare

(Actual Size)

Absolutely Watertight! Astonishingly Compact! Weight only 6⅞ oz. Length 5⅛", diameter 1⅝". Automatic pull-ring ignition by special A-P fuses. Remains cool in hand during use. Soon available as the "A-P DAYNITE DISTRESS SIGNAL" to all Airlines, Merchant Marine, Sportsman Flyers and Yachtsmen through dealers from Coast to Coast. Folder on request. AERIAL PRODUCTS, Inc., Merrick, L. I., N.Y.

The new Ward LaFrance civilian trucks now beginning to roll off our assembly lines offer you **plus values** in power, rugged construction, dependability and low hauling costs. You have never seen anything to match them.

THE TOUGHEST, MOST ECONOMICAL BIG TRUCKS MONEY CAN BUY . . .

Don't take our word . . . . . take a demonstration.

We know this because they are the civilian version of our military models which have been called on to do the toughest jobs any trucks ever were asked to perform, and proved themselves over millions of miles, in combat, all over the world.

Here's a truck that is new, better, **proved.** Forget the limitations you've become used to in the past. Think in terms of what you think a heavy truck **should** do, not what they always have done. Then give Ward LaFrance the chance to prove that it can deliver, right to your "ideal" specifications. If we have not yet appointed a dealer in your community, write our Sales Department outlining your requirements as fully as possible.

WARD LAFRANCE

TRUCK DIVISION

GREAT AMERICAN INDUSTRIES, INC.

ELMIRA, NEW YORK

FRANCHISES AVAILABLE in several top-notch localities. Especially desirable for established dealers handling leading smaller, non-competitive makes . . . For complete details of the new profit-making Ward LaFrance Dealer Plan, write our Sales Department today.

the tomorrow that came today!

It didn't come the way you may have thought it would. It hasn't changed your everyday life much . . . as yet. In fact, it wouldn't be surprising if you are still thinking about the Air Age as something promised for *tomorrow*. But take a look at what has actually happened.

Recently adopted as the standard aircraft for Troop Carrier combat operations, the Curtiss C-46 Commando is equipped with jump doors on both sides of fuselage . . . can drop 36 paratroopers in double streams.

Just recall the historic record-breaking day when 14,000 planes were over Germany in one 24-hour period. That meant probably 50,000 men in the air at one time. Thousands of tons of bombs, shells, medicine, food —delivered to one country within a few hours. *Mass air travel and mass air-cargo transport are here!*

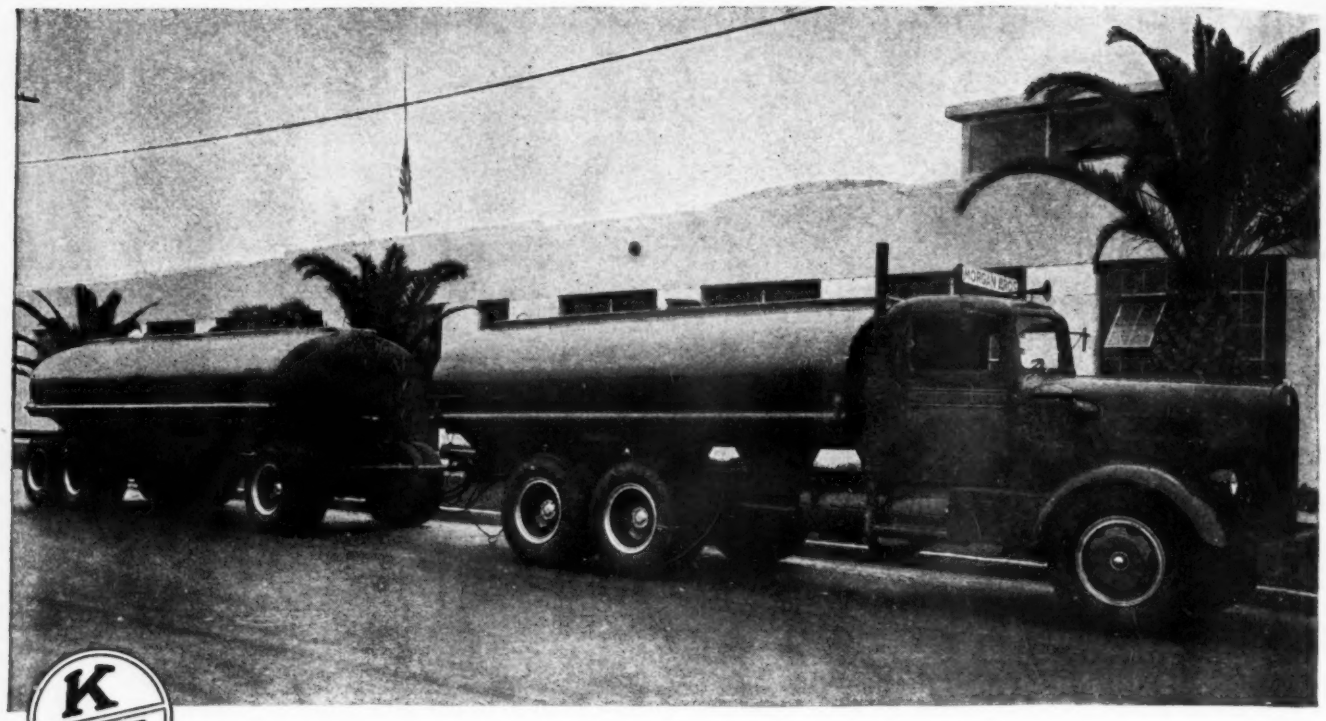
Huge, modern air transports, powered by Wright Cyclones, with cargo space nearly equal to two average box cars, now fly across the country coast-to-coast in approximately 6 hours . . . Giant planes have taken off every 13 minutes to hop the Atlantic and every 90 minutes to span the Pacific . . . 3 Curtiss Commandos recently transported 23,000 pounds of critical radar equipment from Miami to India in just 4 days . . . You are living in the Air Age *right now!*

To make air travel convenient, hundreds of air terminals are already established — more on the way. For instance, 15 nations are already seeking landing facilities at New York's new Idlewild airport. Set your hopes high—the Air Age has already begun.

FIRST IN FLIGHT

Curtiss-Wright

AIRPLANES • ENGINES • PROPELLERS



Supercharged Rolling Power

The men of Army Ordnance are familiar with the many tough military trucks built by Kenworth for service at the battle-fronts. Even before Pearl Harbor Kenworth's prime concern was to gear its operations to the needs of the Army.

While Kenworth-built military vehicles served at the fighting fronts, other fleets of Kenworth trucks helped to keep the home front rolling toward Victory, and Kenworth engineers continued to plan for the trucks of tomorrow.

It was another first for Kenworth when this truck was added to the fleet operated by Morgan Brothers in Southern California, for this is the first truck equipped with the new Cummins NHBS-600 supercharged engine to be delivered on the Pacific Coast.

Every year more fleet owners are taking advantage of the increased operating profits made possible by heavy duty Kenworth trucks, engineered specially for the requirements of the job.

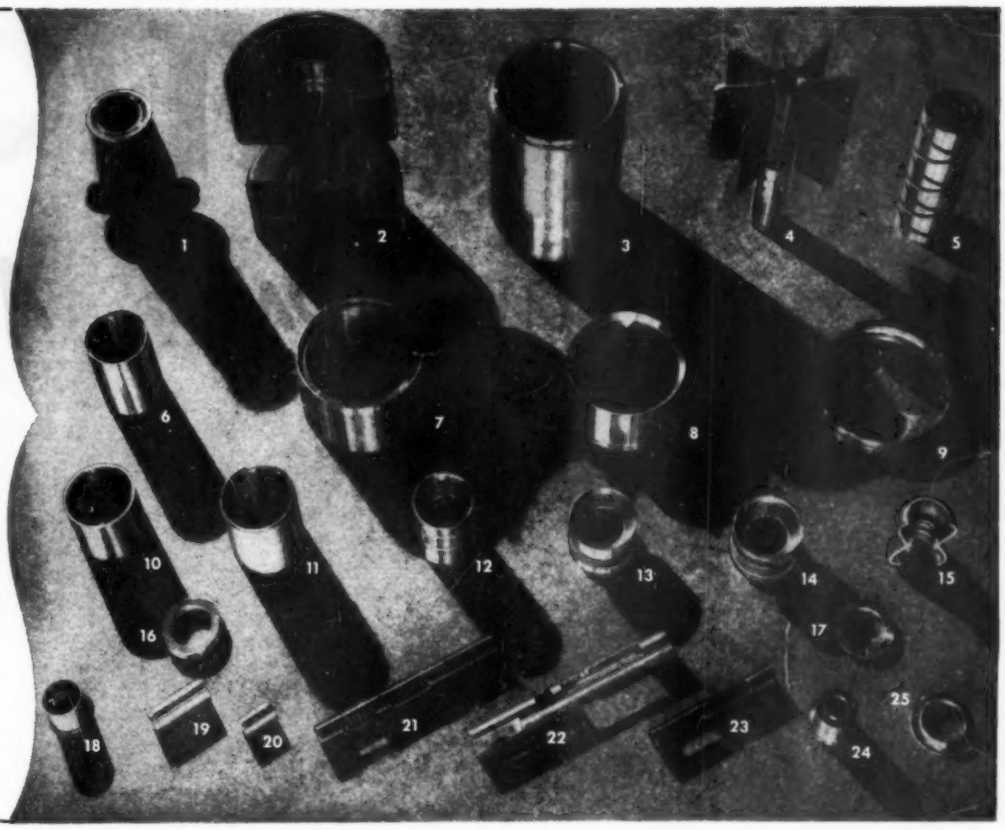
KENWORTH

TRUCKS ★ BUSES ★ TRAILERS ★ FIRETRUCKS

FACTORY AND HOME OFFICE: SEATTLE • *DISTRIBUTORS IN* PRINCIPAL WESTERN CITIES AND HAWAII

They are all made from Shelby Seamless Tubing

1. Contact Coupler for searchlight truck
2. Top roller for half-track
3. Bogie wheel hub
4. Impeller
5. Winder cam for textile machine
6. Finished connecting rod bearing
7. Main crank shaft bearing shell
8. Finished crank shaft bearing
9. Spinning ring for rayon machine
10. Finished propeller shaft bearing
11. Steel shell for propeller shaft bearing
12. Finished steel-bronze bearing
13, 14. Clutch-bearing shells
15. Roller for conveyor
16. Spacer for bearings
17. Bearing shell
18. Airplane engine suspension cylinder
19, 20. Finished bearings
21, 22, 23. Cartridge receivers for small arms
24. Airplane engine suspension, steel-rubber-steel
25. Finished clutch bearing



IN MAKING PARTS LIKE THESE,

Seamless Steel Tubing will help...

THESE parts have one characteristic in common--they have all been designed to utilize the basic advantages of seamless steel tubing. Many of them were previously made by forging or by machining from solid stock.

Such methods were comparatively slow and wasted a considerable amount of valuable metal. Often the percentage of rejects was alarmingly high.

By skillful redesign, starting with an accurately made seamless tube, production in many cases has been doubled and even tripled. Man and machine time have been cut to the core. Finished parts are more uniform, and, in some cases, rejects have been reduced to zero.

It is easy to see how these faster, better methods will trim off unnecessary costs. Savings as high as 50% are not uncommon.

When products are redesigned, SHELBY Seamless Mechanical Tubing may save money, save materials and result in better products. Blueprints or sketches of designs will be carefully examined and suggestions cheerfully made without obligation.

1 ***Speed up production***

2 ***Make a better product***

3 ***Save money, time and steel***

NATIONAL TUBE COMPANY
Pittsburgh, Pa.

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
United States Steel Export Company, New York

UNITED STATES STEEL

PROTECTION

against CORROSION and ABRASION

with

WITCO #77 Metal Protector

Witco #77 Metal Protector is a material formulated specifically for application to the underside of fenders, chassis, and underbody members to give protection against the corrosion and abrasion caused by splashing water and flying sand and gravel. It seals cracks and seams and gives thermal insulation and sound deadening. Hence Witco #77 also has numerous applications as a thermal insulator for tanks, freight cars, and other steel fabrications.

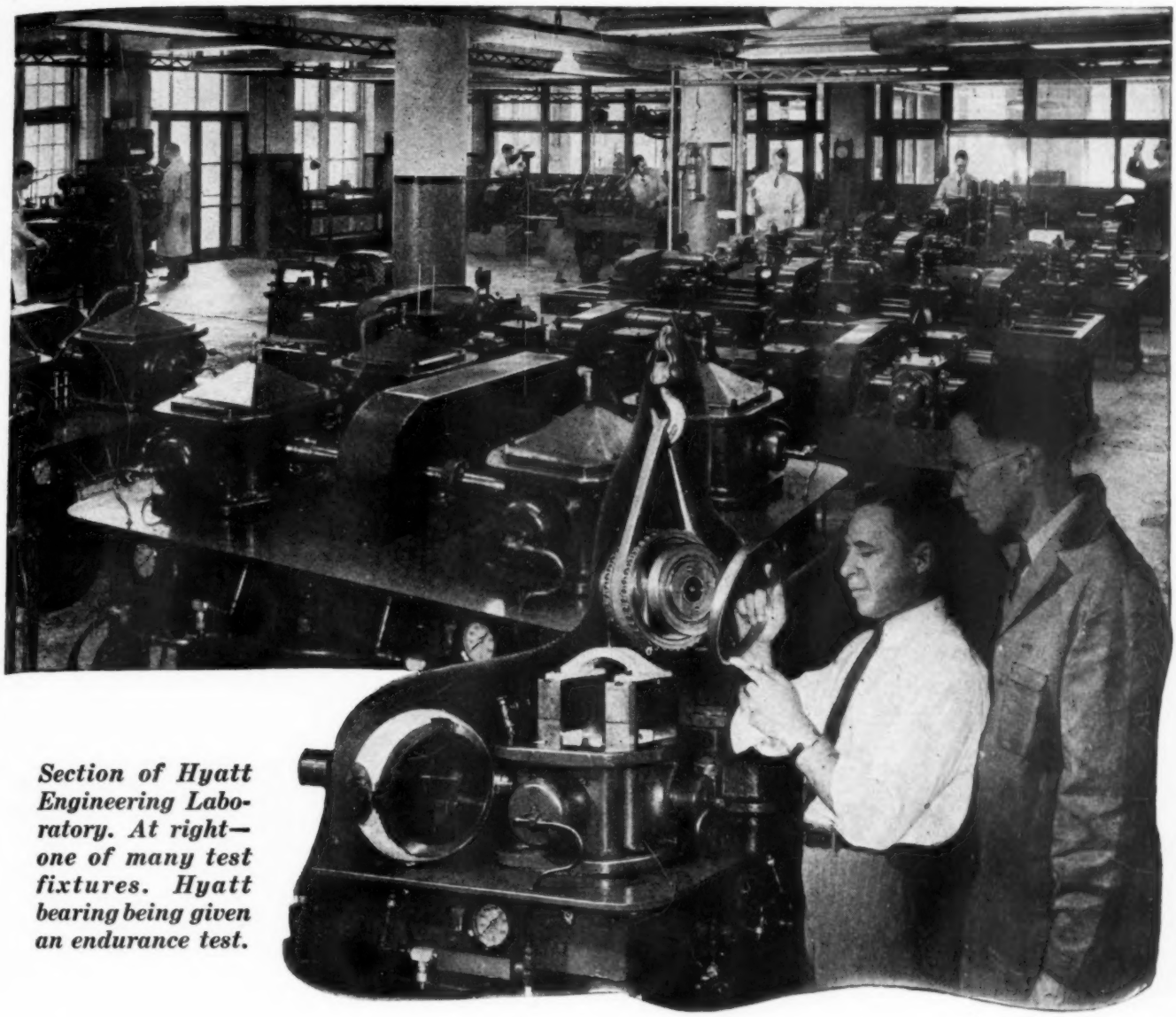
Witco #77 Metal Protector is applied with standard mastic spray gun equipment and dries to touch in 10 minutes—hard in 60 minutes. It may be applied over bare, slightly oily, primed, or painted surfaces, and safely baked at 275 F after 5 hours air dry (or at slightly lower temperatures after shorter drying periods).

Full technical data will be supplied promptly on request.

WITCO CHEMICAL COMPANY

435 N. MICHIGAN AVE. CHICAGO 11, ILL. • ESTABLISHED 1920 • 7338 WOODWARD AVE. DETROIT 2, MICH.

There may be a Diesel locomotive... a power shovel or a loom in this room



Section of Hyatt Engineering Laboratory. At right—one of many test fixtures. Hyatt bearing being given an endurance test.

EACH DIFFERENT TYPE of application makes its own special demands of Hyatt Roller Bearings—with such destructive forces as speed, impact, radial or thrust loads, and others—as well as conditions of moisture, wetness, heat, cold, dust, dirt.

It is traditional to build Hyatts with endurance to outlast the equipment for which they are designed. Our way of making sure of their capacity to do so is to simulate the conditions of the job—whether it's that of a massive locomotive journal box or a feather-weight, high-speed spindle on a textile loom—in our 24-hour-a-day testing laboratory.

Here, dozens of individual tests go on all the time—even to running bearings to destruction to prove their correctness of design.

Any bearing, in any stage of production may be picked for these tests by Hyatt's roving test engineers. This random selection is added assurance to the Hyatt Roller Bearing user that both workmanship and metallurgical standards are adhered to throughout the entire manufacturing process.

Hyatt engineers gladly consult with you on the selection of the proper Hyatt Roller Bearings for your product. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

HYATT ROLLER BEARINGS

"Now, I'm going to write a letter to myself"

"THIS WAR was plenty tough and I, for one, am going to try to keep it from happening again. One thing is certain. We must keep our motor transport system what it is today — the best in the world. It helped us win the war and it will help us win the peace."

• • •

MOTOR TRANSPORT does hold the key to future peace and security. From now on it must play a dual role. It must help rebuild the war-torn world and at the same time develop the military vehicles necessary to assure the nation the most efficient mechanized military force in the world.

Whatever the role of Motor Transport, Timken Axles will continue to be closely associated with the development of vehicles for every military or commercial purpose. In the future as in the past, our facilities for research and development will be at the constant disposal of our military leaders who will keep our fighting equipment abreast of the times—so that if war should ever come again, America will be ready.

TIMKEN AXLES

TIMKEN AXLES

THE TIMKEN-DETROIT AXLE COMPANY, DETROIT 32, MICH.
WISCONSIN AXLE DIVISION • OSHKOSH, WISCONSIN

"Standard"

ELECTRIC WELDED STEEL TUBING

and Fabricated Tubular Parts for Mechanical, Pressure and Structural Applications.

SIZE AND THICKNESS CHART

TUBE DIAMETER	MAXIMUM WALL		MINIMUM WALL	
*O.D. SIZE	DECIMAL	GAUGE	DECIMAL	B.W. GAUGE
1/4"	.065"	16	.028"	22
3/8"	.065"	16	.028"	22
1/2"	.065"	16	.028"	22
5/8"	.065"	16	.028"	22
3/4"	.065"	16	.028"	22
7/8"	.095"	13	.028"	22
1"	.083"	14	.028"	22
1-1/8"	.095"	13	.035"	20
1-1/4"	.095"	13	.035"	20
1-3/8"	.109"	12	.035"	20
1-1/2"	.120"	11	.035"	20
1-5/8"	.120"	11	.035"	20
1-3/4"	.120"	11	.035"	20
1-7/8"	.165"	8	.035"	20
2"	.180"	7	.035"	20
2-1/4"	.203"	6	.049"	18
2-1/2"	.203"	6	.049"	18
2-3/4"	.220"	5	.065"	16
3"	.220"	5	.065"	16
3-1/4"	.238"	4	.065"	16
3-1/2"	.238"	4	.065"	16
3-3/4"	.250"	3	.065"	16
4"	.250"	3	.065"	16
4-1/4"	.250"	3	.065"	16
4-1/2"	.250"	3	.065"	16
4-3/4"	.250"	3	.065"	16
5-1/2"	.134"	10	.083"	14

*Intermediate sizes within the range indicated can also be manufactured. Please consult us for sizes not listed.

IN the construction of products calling for the use of ELECTRIC WELDED STEEL TUBING, more and more manufacturers have discovered the advantages of specifying the "Standard" brand.

They've found that our wide variety of shapes and sizes gives them the kind of tubing they want. And they've found that our facilities for high speed production of both standard and special types enables them to get specified tubing delivered when they want it. Beyond these highly important considerations, they've discovered that our interested and willing cooperation in the solving of special tubing problems has helped them make their products quicker, better and at lower cost.

If you need a source of ELECTRIC WELDED STEEL TUBING now, or are planning a product that will use this material, let our experience and facilities help you do a better job.

BUY MORE WAR BONDS

THE STANDARD TUBE CO.

Detroit 3, STANDARD Michigan

Welded Tubing *Steel Forgings*

★ *Complete Tube Stocks Maintained by* ★

STANDARD TUBE SALES CORP., One Admiral Ave., Maspeth, L. I., N.Y.
LAPHAM-HICKEY COMPANY, 3333 W. 47th Place, Chicago 32, Ill.
UNION HARDWARE & METAL CO., 411 E. First St., Los Angeles 54, Cal.

MILITARY or COMMERCIAL

—they're BOTH Breeze Shielded

Four Breeze-Shielded Wright Cyclone 18's rated at 2200 HP powered the Boeing B-29 Superfortress in its smashing attacks against the Japanese homeland.

The 55-passenger Lockheed Constellation, whose trans-continental record of 6 hours, 58 minutes was powered by four Breeze-Shielded Wright Cyclone 18's

● For many years Breeze has been recognized as the General Headquarters for Radio Ignition Shielding. The reputation which the products bearing the Breeze Mark of Quality built up on national and international airlines before the war has now been augmented by the service record of thousands of Breeze Shielding Assemblies for America's famous fighting aircraft, tank, marine and commercial engines. Now that final victory has been won, Breeze returns to production of Shielding for commercial applications without delay for reconversion. And the reservoir of Breeze Shielding experience so materially increased in maintaining dependable communication in war, once again is available to help pace progress in peace.

BREEZE

Corporations Inc.

NEWARK 7 BREEZE MARK NEW JERSEY

Other Breeze Products ● SHIELDING FOR AIRCRAFT ● MARINE ● ELECTRONIC APPLICATIONS OF ALL TYPES

AN "E" BOUQUET for the ARMY!

Up to now it's been the *Army* that handed out the praise for work well done—giving us, incidentally, a more than generous share.

Let's reverse that. We'd like to tell the *Army* what a great job it did, working with *us*. Here's an "E" bouquet for the men responsible—the Army's able engineers and metallurgists, of the Tank Automotive Center, Watertown Arsenal, and the Ordnance Districts—the men we rolled up our sleeves and sweated blood with.

We only hope that our cooperation, our give-and-take, in the strenuous years that started long before Pearl Harbor, when we wrestled together with ever-changing designs and specifications in an ever-changing war, was productive of lasting benefit.

To the Army, then, our congratulations and sincerest thanks for doing everything, and *then* some, to make our World War II job both productive and practical.

AMERICAN STEEL FOUNDRIES
CHICAGO

MINT-MARK OF ⬡ FINE CAST STEEL

• • •

TINY GIANT WITH A HISTORY

Long before the war, the men who design your Bell Telephone System were looking for an electron tube with frequency capabilities never before attained. With it, they could transmit wide bands of telephone messages — several hundred of them — simultaneously through coaxial cable — economically, and over long distances.

They developed a tube which set a new standard in broad-band, high-frequency amplification. So minute that its electrode system had to be inspected under a magnifying glass, the tube could amplify either the voices of 480 people talking at the same time, or the patterns of television. Long-distance transmission became a commercial reality.

6AK5

Cross-section of Electrode System (five times actual size)

When war came, this tube excelled all others as an amplifier in certain military equipment. It then grew into the 6AK5, one of the great little tubes of the war. Besides producing 6AK5's in large quantities, the Western Electric responded to emergency needs of the Army and Navy by furnishing design specifications and production techniques to other manufacturers, of whom at least five reached quantity production. On every battlefront it helped our ships and planes to bring in radio signals.

Developing electron tubes of revolutionary design has been the steady job of Bell Laboratories scientists ever since they devised the first practical telephone amplifier over thirty years ago. Now tubes like the 6AK5 will help speed the living pictures of television, as well as hundreds of telephone conversations simultaneously over the coaxial and radio highways of the Bell Telephone System.

BELL TELEPHONE LABORATORIES

Exploring and inventing, devising and perfecting for continued improvements and economies in telephone service.

Flash — On every competitive test to date, LaPlant-Choate's new 8-yard cable-operated scraper has "run rings around" all other competitive scrapers tested. A limited number are already in the field, with everything set for economical mass production as soon as military conditions permit. You'll agree — it's a scraper well worth waiting for!

THOUSANDS OF SATISFIED OWNERS AGREE

It's LPC *for* LOWEST POSSIBLE COST

TRADE MARK

There are many good reasons why thousands of successful operators who have been using LaPlant-Choate rigs for years will keep right on buying them after the war. For one thing, these long-time users know from experience that LPC dozers and scrapers consistently move more yardage faster and at lower cost. They also know that LaPlant-Choate performance and dependability have been *job-proved around the world* under all types of conditions. And best of all, these veteran operators know that LaPlant-Choate will continue to lead the way in developing new improvements because LPC's entire organization is *strictly "tractor-equipment-minded"* . . . with more years of specialized "know-how" than any other company in the industry. So it all adds up to LPC—for lowest possible cost and better results—on your jobs, too. See your LPC-"Caterpillar" distributor today. LaPlant-Choate Manufacturing Co., Inc., Cedar Rapids, Iowa; San Leandro, California.

ARMY E NAVY

LAPLANT CHOATE

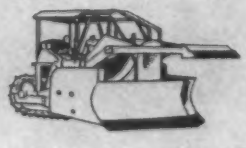
EARTHMOVING AND LAND CLEARING EQUIPMENT

THERE IS A JOB-PROVED LA PLANT-CHOATE RIG FOR EVERY EARTHMOVING AND LAND CLEARING NEED

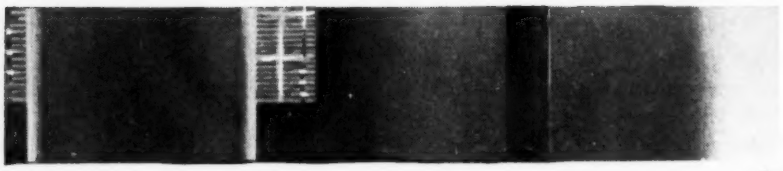
ALL TYPES OF DOZERS — Straight or angling blade, hydraulic or cable operated, for every size of track-type tractor.

LARGE OR SMALL SCRAPERS — Hydraulic or cable operated, front or rear dump, for use with your wheel or track-type tractors.

CABLE OPERATED RIPPERS — For ripping up hard ground, shale or concrete to facilitate loading with LPC "Carrimor" Scrapers.



LAND CLEARING TOOLS — A complete line of Brush Cutters, Treedozers, Rootcutters and Brush Rakes—all are interchangeable.



WHITTLING STEEL BY *Finger-tip Control*

It takes unyielding power to *whittle* steel, yet broaching machines do just that. Like tandem chisels, the cutting edges on the powerful ram of a broach carve useful shapes in rough castings or forgings of tough, hard metal. Being able to perform six machining operations in a single cycle of its great ram, one operator on a broach equipped with HYCON *Finger-tip Control* can out-produce ten milling machines employing eight men . . . a potent consideration in planning economical production for the competitive marketing era now at hand.

Providing *measured pressures* of 3000 pounds per square inch, HYCON pumps and valves, or assembled complete power units, are available for countless industrial applications.

Testing high-pressure apparatus
Operating remote-control circuits
Lubricating under pressure
Relieving starting torque on heavy machinery
Applying as equalizers on dryer and Fourdrinier rolls on paper-making machinery
Actuating or controlling heavy machine tools, materials-handling mechanisms, dump-truck lifts and heavy jacks

Let HYCON engineers assist you in applying *Finger-tip Control* to the improvement of products or plant operations where the problem is one of actuation or control.

Write for complete information.

A FIFTH STAR FOR EXCELLENCE IN WAR PRODUCTION

★ ★ **HYCON** ★ ★

REGISTERED TRADE MARK

FOR PRESSURES OF 3000 P. S. I.

High-Pressure Hydraulic Systems

Patented—Manufactured only by The New York Air Brake Company

★

THE NEW YORK AIR BRAKE COMPANY

Hydraulic Division

420 LEXINGTON AVENUE NEW YORK 17, N. Y.

Factories • Watertown, New York

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Building *Morale* in the Outposts

After working from one to three years in an outpost of the world, a man may have small liking for his job if thirty days or more are chopped off each end of his precious leave by slow travel. Sluggish river boats, tortoise-gait trains and ten-knot steamers are no pace for a man impatient to get home.

By air, there are no more outposts, in the travel sense.

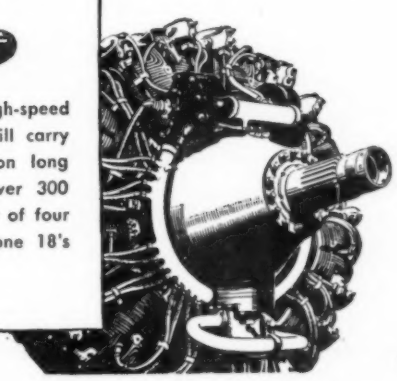
No spot on earth is more than three days away by plane. Travel by air means an extra six to eight weeks of vacation, more rest and more rebuilding of that drive and spirit which keeps trade moving in the far-off corners of the world. And travel-time pay is saved by the governments and corporations who hire these men.

In the past few years, this type of travel has changed from prediction to reality. It was made possible by the development of modern transport planes, the extension of world air routes, and by the power, economy and reliability of aircraft engines for all types of planes.

On leading airlines the world over, the first choice of power is Wright Cyclone aircraft engines. They help build up both trade and the morale of the men who create that trade in isolated areas.

THE JOB FOR PLANES TO COME

In future air commerce, the high-speed double-decked Boeing C-97 will carry both passengers and cargo on long range flights. It cruises at over 300 miles per hour from the power of four air-cooled radial Wright Cyclone 18's of 2,200 HP each.



WRIGHT

AIRCRAFT ENGINES

DIVISION OF

CURTISS WRIGHT

FIRST IN FLIGHT

Wright Aeronautical Corporation • Paterson, New Jersey, U. S. A.

THE MODEL 1944 JOHNSON AUTOMATICS

JOHNSON LIGHT MACHINE GUN OR MACHINE RIFLE

Caliber .30-'06—Weight 15 lbs. with mount. Capacity 25 shots.

The monopod mount folds to form the forestock for shoulder firing, either full or semi-automatic, from any standard rifle position. Combat peep sight and battle range front give point-blank range of nearly 300 yards.

Write for FREE illustrated folder of general information on Johnson Arms

CUSTOM GUN DEPARTMENT

With the changes brought about by complete Victory, we are resuming activity in our Custom Gun Department, and are now in a position to furnish prompt service on the following jobs:

REBARREL YOUR SPRINGFIELD MAUSER ENFIELD RIFLE in .30-'06

WE WILL—Furnish and fit a new .30-'06 barrel of 26″ or less to your action, blue the barrel, action and fittings and check the headspace for	$35.00
Alter Mauser Magazine for .30-'06 cartridge	3.50
Furnish and attach band ramp front sight	9.25
Furnish and attach micrometer rear sight	15.00*

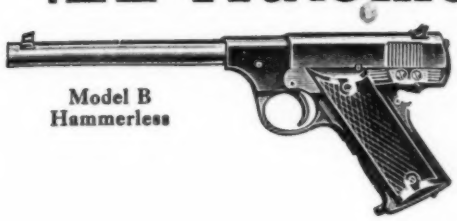
*There is an extra charge for removal of Enfield issue sight.

Estimates on stock work and targeting furnished upon request.

General information on Johnson Military Arms on request.

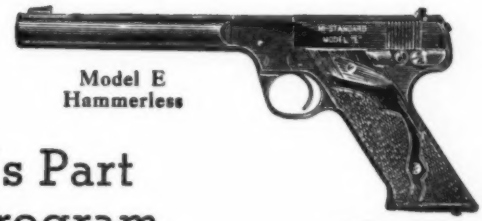
JOHNSON AUTOMATICS
DEPT. A
PROVIDENCE 1, RHODE ISLAND

HIGH STANDARD
.22 Automatic Target Pistols



Model B
Hammerless

BUILT TO EXTREME PRECISION STANDARDS BY GUN EXPERTS



Model E
Hammerless

Hi-Standard's Part In The War Program

is the manufacture of machine guns for the army and navy, and deep-hole drills for other manufacturers supplying machine guns, rifles, tanks, trucks, and airplanes. On both these items, we are in full production.

Model HE
Visible Hammer

THE HIGH STANDARD MFG. CORP., NEW HAVEN, CONN.

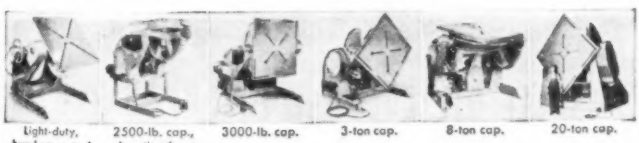
We'll hold it while you weld it...

IF you're doing a welding job on war production, you can get Ransome Positioners to help you increase your output and reduce costs.

With this modern equipment, your welders can readily swing the heaviest and most complicated pieces for a downhand position on every pass . . . top, sides, and bottom, with one set-up.

Made in a complete range of types and sizes . . . hand-operated and motor-operated . . . up to 20-ton capacity . . . there's a unit that will fit your needs exactly.

● *Write for literature on Ransome Positioners*



Light-duty, hand-operated | 2500-lb. cap., elevating base | 3000-lb. cap. | 3-ton cap. | 8-ton cap. | 20-ton cap.

Ransome WELDING POSITIONERS
INDUSTRIAL DIVISION • RANSOME MACHINERY COMPANY • DUNELLEN, NEW JERSEY

KOEHRING POWER — built into the shovel from engine to clutches, gears, and crowd—power that flows without loss or interruption to the digging dipper—is the "stuff" that counts to maintain high speed maximum production on day and night working schedules.

KOEHRING STRENGTH — built into the shovel to "take" the power—strength without a weak link—Heavy-Duty construction—from crawlers to dipper—is the quality required for high speed digging in all types of material. Dirt or rock, Koehring strength is digging strength.

KOEHRING COMPANY • MILWAUKEE, WISCONSIN

Heavy Duty Construction Equipment

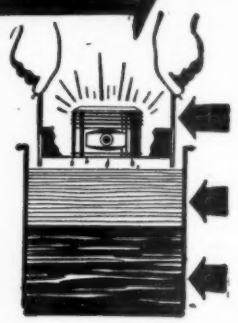
GUNK H. S. DUNK

FOR CARBON DEPOSITS, OIL VARNISH, CLOGGED OIL LINES
FUEL PUMPS, CARBURETORS, OIL COOLERS, FUEL INJECTORS

Gives a Complete Strip
—not a strip tease
HARMLESS TO ALL METALS
Tough on Tar, Carbon

GUNK has been doing an outstanding job for the Army and Air Forces. Exceeds latest Government degreasing and decarbonizing specifications.

Thoroughly strips gasoline, gums, lead, and paint. Restores both base metal and small brass control screws, jets, valves, etc., to original factory-bright appearance. No etching . . . . no loss of dimensions, discoloration or harmful effect to metal parts. Gunk Dunk comes ready to use with patented dunking screen in 5-gallon container—a complete decarbonizing package outfit.



GUNK Dunk is easy to use

The dunking screen that comes with the kit

The hydro-seal—a water base blanket that forms on top like cream on milk and prevents evaporation of concentrate, rinses work

GUNK (H-S) DUNK, digests carbon, gum

THE CURRAN CORP.
Manufacturing Chemists
MALDEN 48, MASS.

Makers of:
GUNK-Spray, *self-emulsifying chemi-cleaner.*
GUNK-Dunk, *carbon gum digestant.*
MOTOR-FIZIK

Experts IN THE MANUFACTURE OF

ZEROL GEARS

WE RECOMMEND ZEROL GEARS FOR SMOOTHER QUIETER OPERATION WHEN STRAIGHT BEVEL GEARS ARE CONVENTIONALLY USED

GEARS OF ALL TYPES and MATERIAL—UP TO 36"
MADE *Exactly* TO YOUR SPECIFICATIONS

DETROIT *Bevel Gear* COMPANY
8130 JOS. CAMPAU AVE. DETROIT 11, MICHIGAN

SHELL

Symbol of Quality

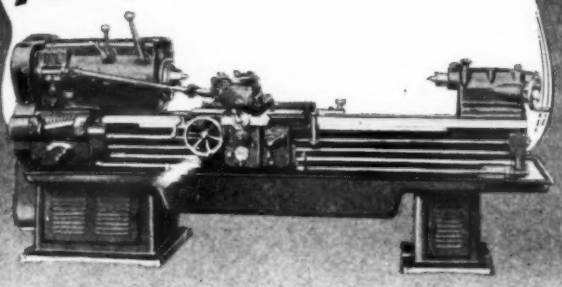
The constant improvement of Shell fuels and lubricants is the never ending task of Shell Scientists. Shell's great research organization has contributed much to the successful prosecution of the war and to a better way of living.

No matter how difficult the problem or how rigid the requirements, you can always depend on Shell.

SHELL OIL COMPANY, INCORPORATED

Oil is ammunition—Use it wisely

Tuned to TOOLROOM TOOLING

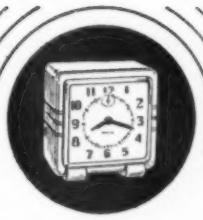


Tuned finer than the most sensitive musical instrument—yet rugged, powerful, accurate and simple to operate—a functionally correct precision lathe made especially for the toolroom. Its many exclusives and man-hour saving features will be a revelation. Four sizes—12", 14", 16", 18".

LeBlond is making Tomorrow's Toolroom Lathes Today.
Write for catalog.

THE R.K. LeBLOND MACHINE TOOL CO.
CINCINNATI 8, OHIO

LARGEST MANUFACTURER OF A COMPLETE LINE OF LATHES



MANUFACTURING PRECISION MECHANISMS

FOR THE ARMED FORCES

The New Haven plant, occupying almost two city blocks, is busily engaged in producing complete instruments and various vital parts urgently needed for the war effort.

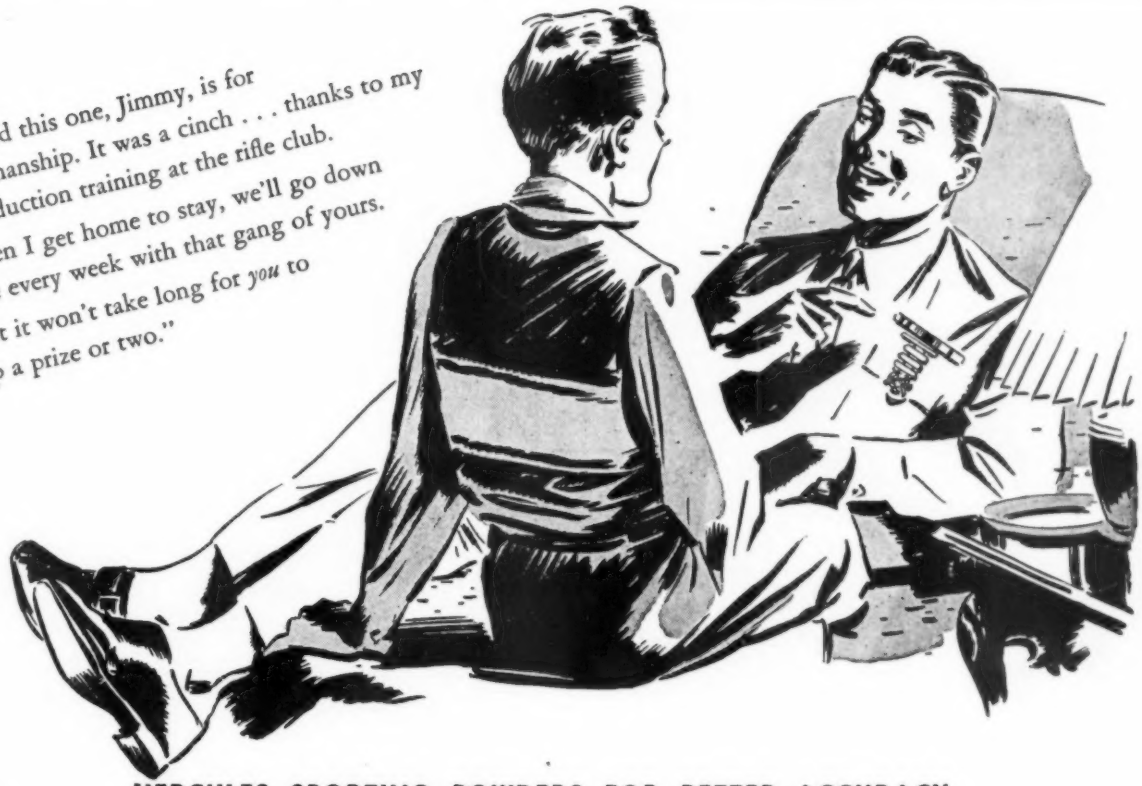
Back of this production is 127 years' experience in the manufacture of fine clocks and watches.

THE NEW HAVEN CLOCK COMPANY

NEW HAVEN, CONN.

Fine craftsmanship since 1817

● ". . . and this one, Jimmy, is for marksmanship. It was a cinch . . . thanks to my pre-induction training at the rifle club. "When I get home to stay, we'll go down there every week with that gang of yours. "Bet it won't take long for *you* to cop a prize or two."



HERCULES SPORTING POWDERS FOR BETTER ACCURACY

HERCULES POWDER COMPANY
INCORPORATED

SPORTING POWDER DIVISION • 912 KING STREET • WILMINGTON 99, DELAWARE

XS-53

FEDERAL PROTECTIVE EQUIPMENT
FOR LAW ENFORCEMENT AGENCIES

The Federal Gas Gun and Flite-Rite Projectiles are used for dislodging barricaded criminals and insane persons. The Federal Gas Gun and Spedeheat Projectiles, Short Range Shells and Flares, also Grenades, are used for controlling rioting and disorderly groups. You can handle such disorders with gas and avoid casualties resulting from firearms.

Federal 1½" Caliber Gas Gun fires shells pictured left

Short Range Gas Cartridge or Parachute Flare Shell

Spedeheat Projectile

Other Federal Products are Gas Billies; Gas Projectors; Gas Masks; Fusees and Road Flares; Armored Vests and Shields; Gun and Metal Detectors; Revolvers; Ammunition—Official Distributor; Gun Oil and Solvent; Handcuffs; Leather Police Belts and Holsters; Police Clubs and Saps; Police Lights and Sirens; Sound Detectors; H&R Reising Sub-Machine Guns and Automatic Rifles, etc.

Write for Prices on Items in which you are interested

FEDERAL LABORATORIES, Inc.
Factory: 185 41st Street PITTSBURGH, PA.
(Address All Mail to P. O. Box 268, Zone 30.)

Our facilities are available for special research on synthetic work, and other specialized problems.

ARMY-NAVY "E" Production Award.

Jennings
MACHINE COMPANY

- Automatic Feeds and Hoppers
- Special Machines
- Auto Screw Machine Layouts
- Precision Grinding
- Cams
- Form Tools
- Gages
- Fixtures

3452 LUDLOW STREET
Philadelphia 4, Pa.

THE HARVEY METAL CORPORATION
Engineers and Manufacturers

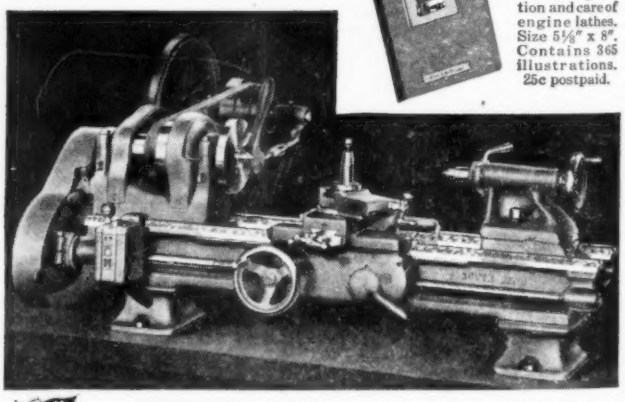
SMOOTH FORGED
BRASS, COPPER and ALUMINUM

CHICAGO, ILL.

EFFICIENT ON
All Types of Machine Work

A fine precision tool, the 9-inch South Bend Lathe is well known in the metal working industries for its exacting, close tolerance performance. Adaptable to all classes of toolroom, experimental and laboratory work, it is equally desirable in production machine shops, automotive and aviation service shops, and maintenance shops. Because of its versatility, accuracy, and speed, the 9-inch South Bend Lathe is highly efficient on all types of machine work. Write for Catalog 100-D.

How To Run A Lathe
128 page book on the operation and care of engine lathes. Size 5½" x 8". Contains 365 illustrations. 25c postpaid.



SOUTH BEND LATHE WORKS
Lathe Builders for 38 Years
437 E. MADISON STREET SOUTH BEND 22, INDIANA

"For Excellency in Production"
of

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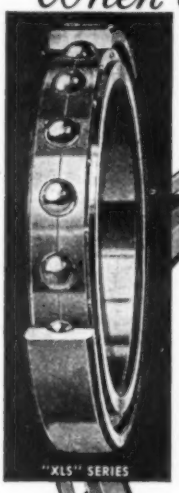

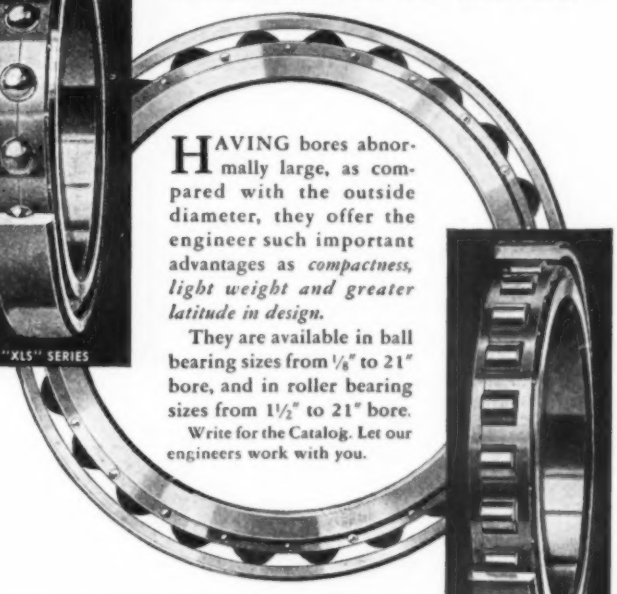

HAVING bores abnormally large, as compared with the outside diameter, they offer the engineer such important advantages as *compactness, light weight and greater latitude in design.*

They are available in ball bearing sizes from ⅛" to 21" bore, and in roller bearing sizes from 1½" to 21" bore.

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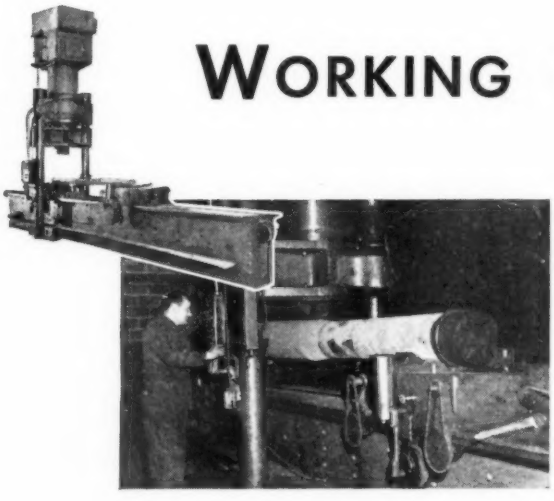

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HYDRAULIC PRESSES

Means...FASTER, BETTER WORK

HELPING TO GET IT OVER . . . OVER THERE
This Farquhar 500 ton Hydraulic Press is straightening a gun-barrel at the American Locomotive Co., Schenectady, N.Y.

This Farquhar catalog may help to solve your production problem. Write for it . . . today.

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These self-contained presses, in capacities from 3 to 7,200 tons, are individually designed and built for specific applications . . . sound reasons why Farquhar presses by the thousands are at work in war plants today.

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Hydraulic Press Division

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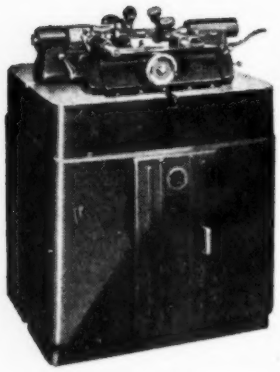
Check GEAR ERRORS

INDEX • HELIX ANGLE • LEAD
TOOTH SIZE • ECCENTRICITY
INTERFERENCE • WOBBLE



WRITE FOR
DESCRIPTIVE BULLETIN

The Red Ring Universal Gear Checker is a simple, compact, instrument for accurately checking dimensional errors in either spur or helical gears. With the application of special equipment, this machine will check leads accurately against a master lead gage, errors being registered on a "tenth" indicator. Its simplicity makes it possible to check gears quickly without sacrificing accuracy. Its ingenious design practically eliminates the human equation and therefore the need for skilled operators.

The Red Ring Universal Gear Checker is built in three sizes, the 12" size for gears from ¼" to 12-11/16" O.D., the 18" size for gears from 2" to 18⅞" O.D., and the 24" size for gears from 3" to 24⅞" O.D.

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SPECIALISTS ON SPUR AND HELICAL INVOLUTE GEAR PRACTICE

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Stretching across the length and breadth of America—from New Haven, Connecticut to Tacoma, Washington, from Dallas, Texas to East Alton, Illinois are the following:

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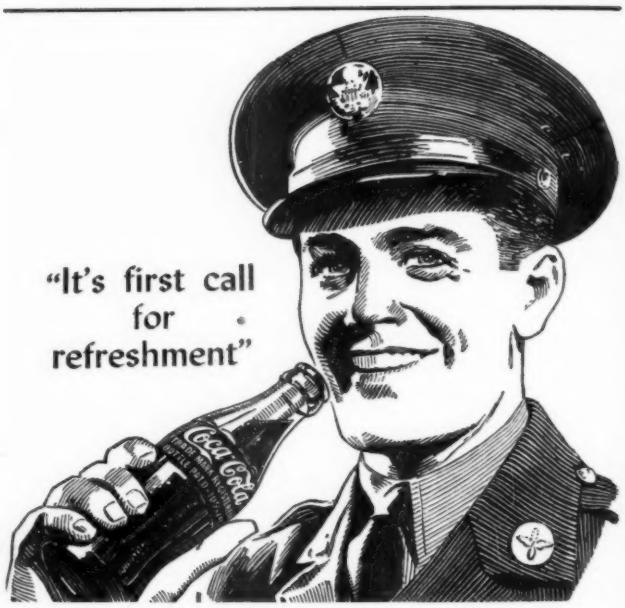
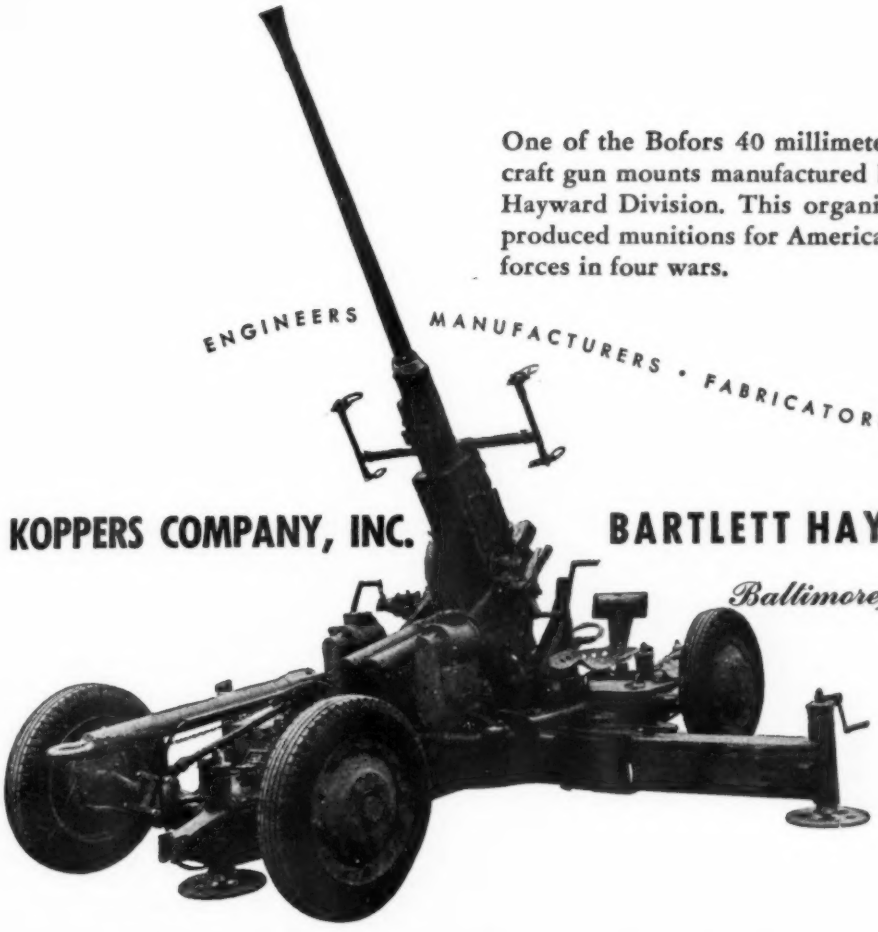


When you're doing your bit on any job, pause and turn to refreshment right out of the bottle,—ice-cold Coca-Cola. A moment for ice-cold Coca-Cola is a little minute long enough for a big rest.

Pause ··· Go refreshed
Coca-Cola

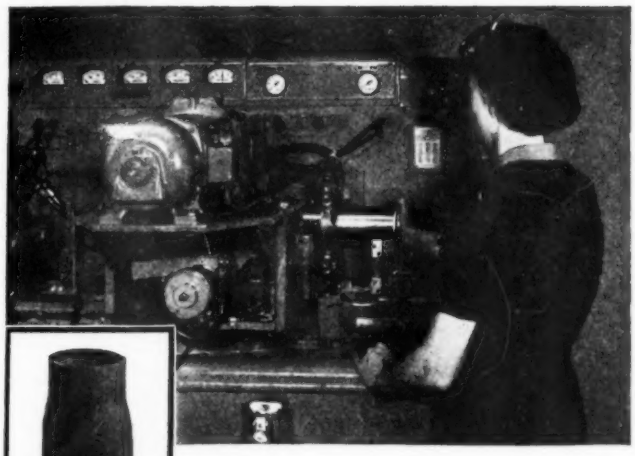


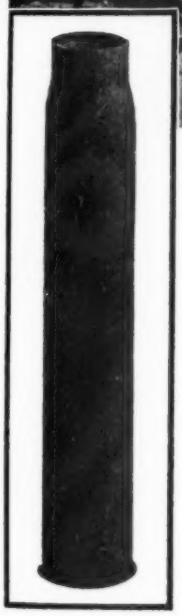
One of the Bofors 40 millimeter anti-aircraft gun mounts manufactured by Bartlett Hayward Division. This organization has produced munitions for American fighting forces in four wars.

ENGINEERS MANUFACTURERS • FABRICATORS • ERECTORS

KOPPERS COMPANY, INC. **BARTLETT HAYWARD DIVISION**

Baltimore, Maryland





THE development of a production method of heat treating steel cartridge cases to make them provide the "fire power" demanded of them, is typical of the aid to the war effort that has made Norris outstanding.

NORRIS

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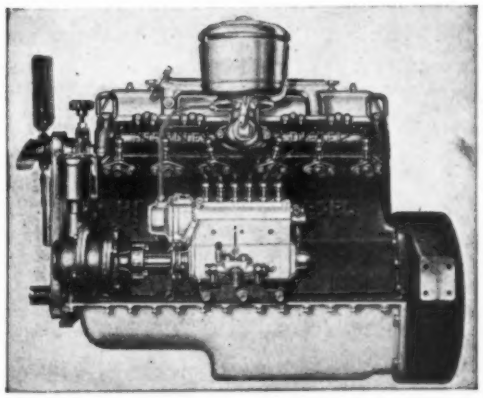
LOS ANGELES · CALIFORNIA
SPECIALIST IN THE ART OF METAL DRAWING



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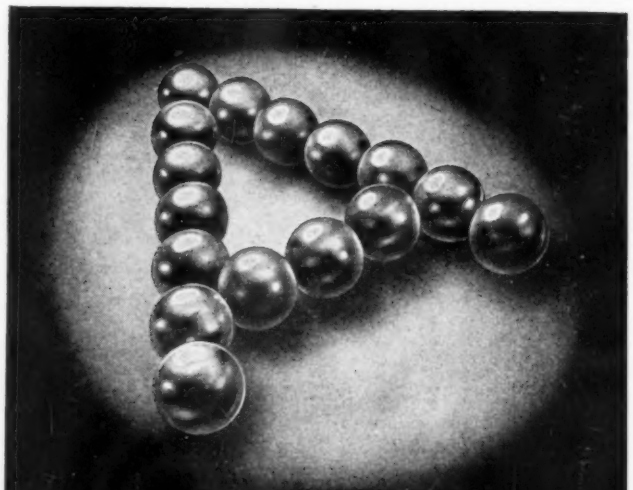

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ARMY E NAVY

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McQUAY-NORRIS MFG. CO.
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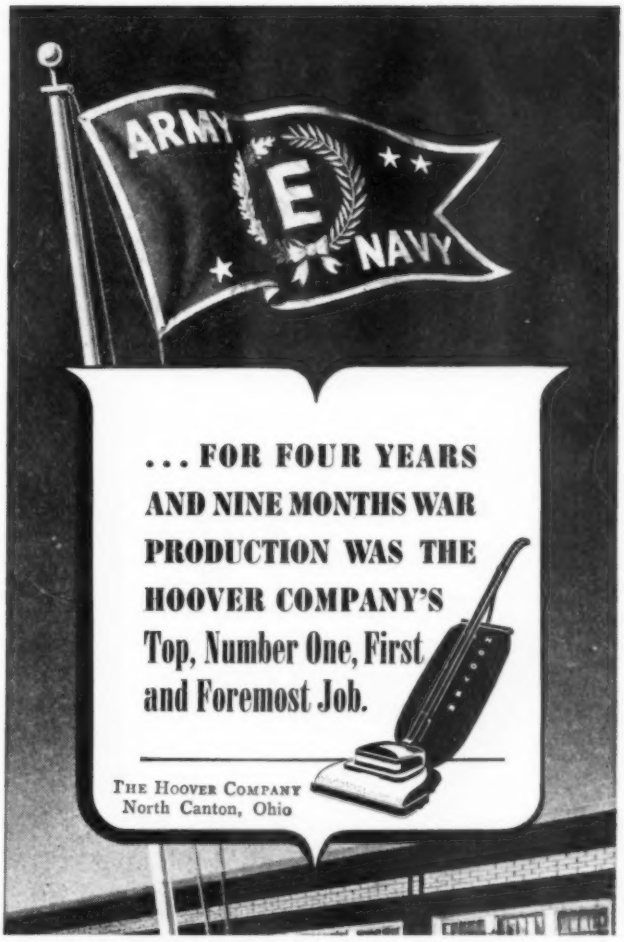
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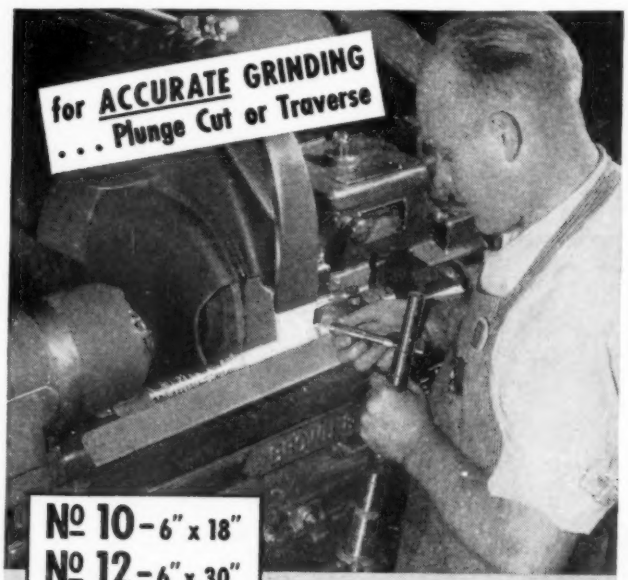

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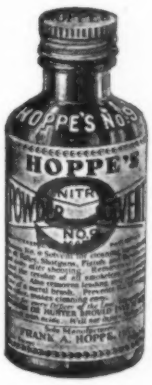

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Preferably small bores—like rifles, revolvers, machine guns, etc. In plain words I *don't* like bore dirt, primer residue, powder soot, metal fouling and/or rust. So I break 'em up—bring 'em out—and provide a test to prove they're out when the job is done. Been specializing on this type of work for forty years and, Mister, you've "*got* to have something" to stick around that long. Soldiers and gun owners know me as

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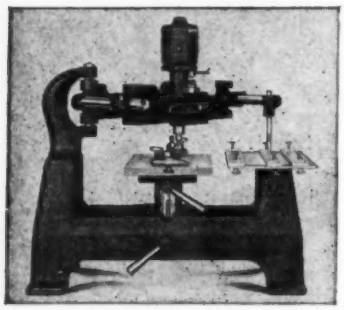

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By means of an ingenuous arrangement of precision lenses and prisms in combination with a lighting system, interior surfaces may be minutely inspected. The magnified image of the field of vision instantly reveals flaws, burrs and other defects.

The illustration shows the simplicity of examination of the bore of a .50 calibre machine gun barrel.

Perhaps we can help you in your difficult inspection problems.

Send us a description of your trouble or blue print of the part in question for a copy of our illustrated booklet, "Industrial Telescopes."

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★ Hydraulic Presses, Bulletin 60
★ Pneumatic Cylinders and Air Control Valves, Bulletin 57
★ Hydraulic Cylinders, Bulletin 35
★ Pneumatic Arbor Presses, Bulletin 46
★ Centrifugal Quenching Press, Bulletin 55
★ "Allen" Pneumatic Riveters, Bulletin 43
★ "Hy-Power" Hydraulic Riveters, Bulletin 53
★ Air Pressure Regulating Valves, Bulletin 56
★ Pneumatic Vises, Bulletin 59

You will find helpful data in these bulletins. Any or all of them will be sent on request.

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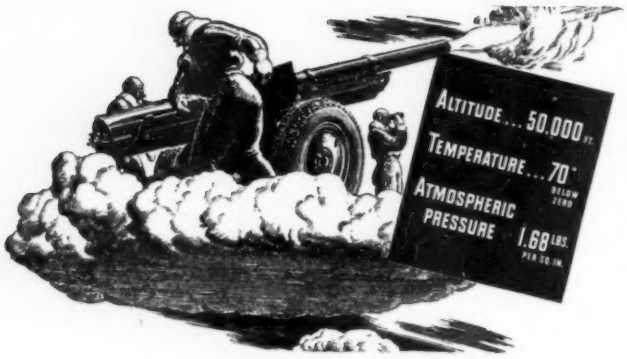

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That's the sixty-four dollar question in the Air Corps today. And to get the answer, York built a twin-cell strato-chamber which simulates the flight of a giant bomber, soaring from sea level to more than 50,000 feet in twelve minutes. In that time, temperature is reduced from +70°F. to −70°F. and air pressure from 14.7 pounds to 1.68 pounds per square inch. Thus U.S. airmen know what happens to firing mechanisms, gun barrels and ammunition subjected to this sudden drop of 140° in temperature. And, as always, what they learn will one day find unsuspected corollaries in the arts of peace. York Corporation, York, Pennsylvania.

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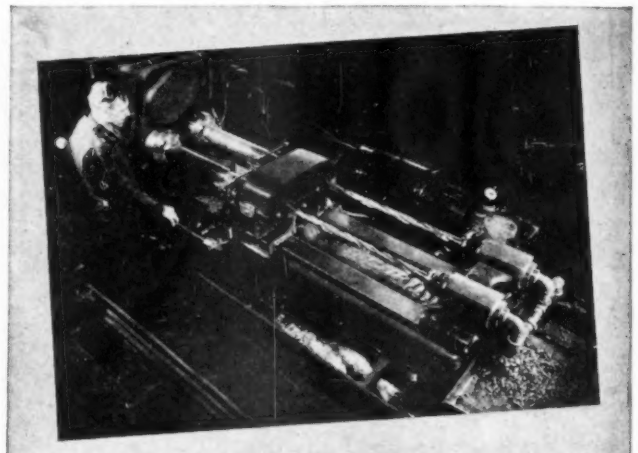

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Minneapolis-Moline is proud of its wartime record of achievement. As of November 1, 1944, according to the best available information, MM was the first in the entire United States to win all of the following awards:

Victory Fleet Flag and Maritime "M" Pennant (Minneapolis Plant) now with five gold stars each denoting six months of high production achievement.

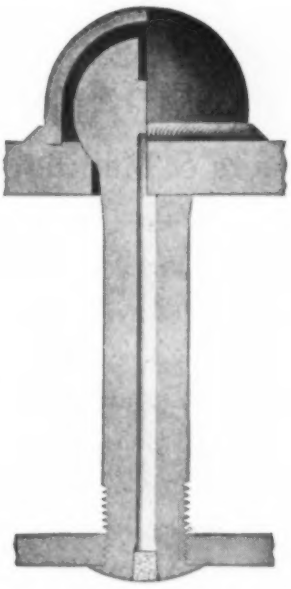
Army-Navy "E" (Como Plant) to which a star has been added for continued meritorious production.

As of above date, Minneapolis-Moline was one of 23 companies in the United States to have earned five consecutive awards from the U. S. Maritime Commission for continued high quality and high productive achievement. MM was one of the first 45 firms in the United States to win the Maritime "M" Pennant. In addition, MM was one of the first 100 firms to set up a Labor-Management Committee. The United States Treasury Department reports that MM was one of the first 100 large firms whose employees invested 10% or better of income in War Savings Bonds. For this, MM proudly displays the Treasury "T" Flag. MM was awarded the Governor's Plant Safety Award for a well-established safety program in every plant and has contributed regularly to the war production fund of the National Safety Council to help prevent industrial accidents. Minneapolis-Moline and its employees regularly support every worth-while endeavor which will help bring final and complete victory.

MM builds many products for our fighting men, and also builds a complete line of modern Tractors and Farm Machinery in quantities as limited by wartime conditions and limitation orders.

MINNEAPOLIS-MOLINE POWER IMPLEMENT COMPANY

Minneapolis 1, Minnesota, U. S. A.



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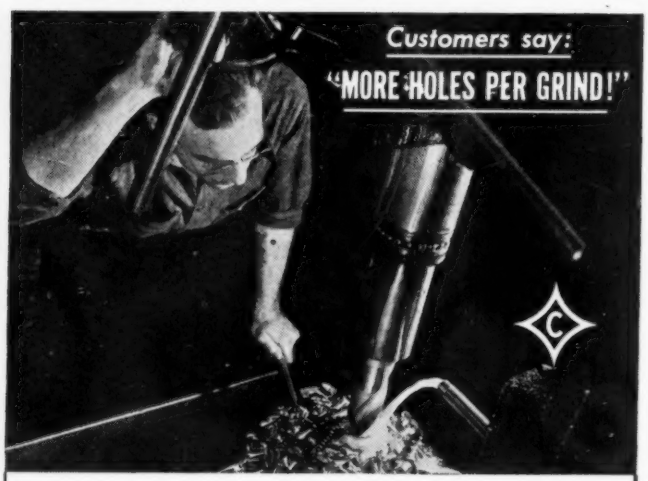

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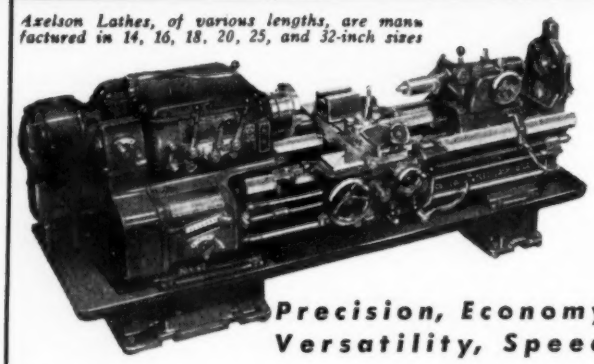

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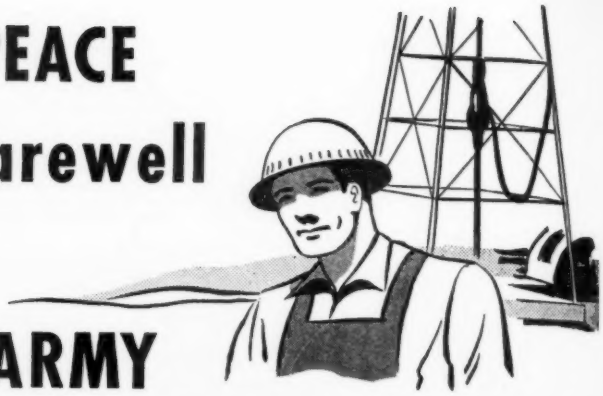

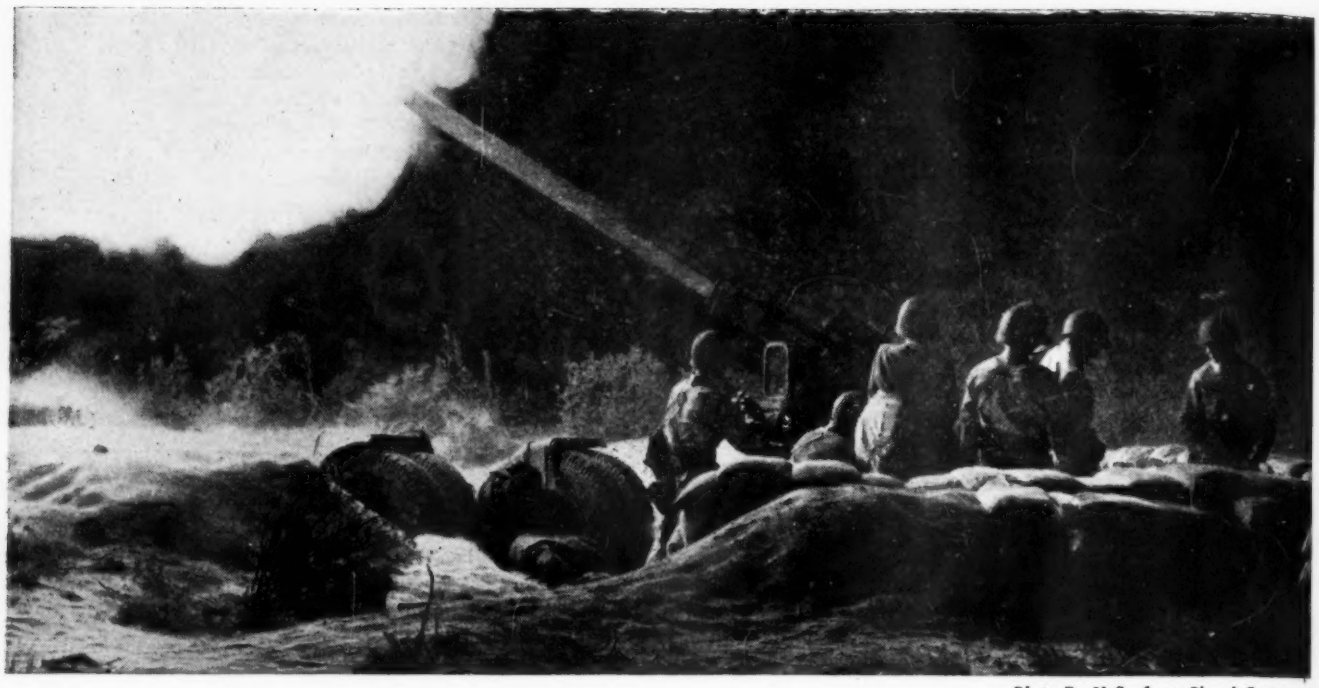

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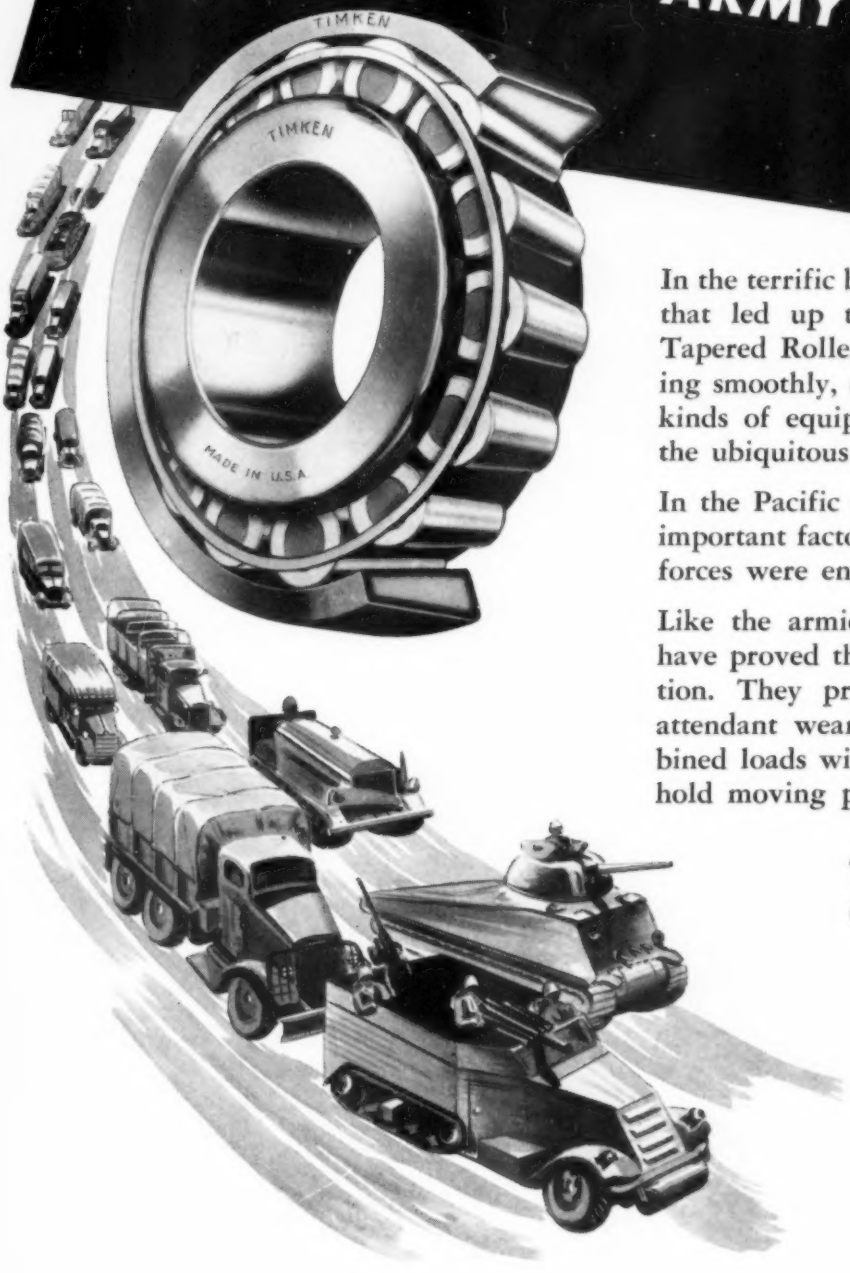

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